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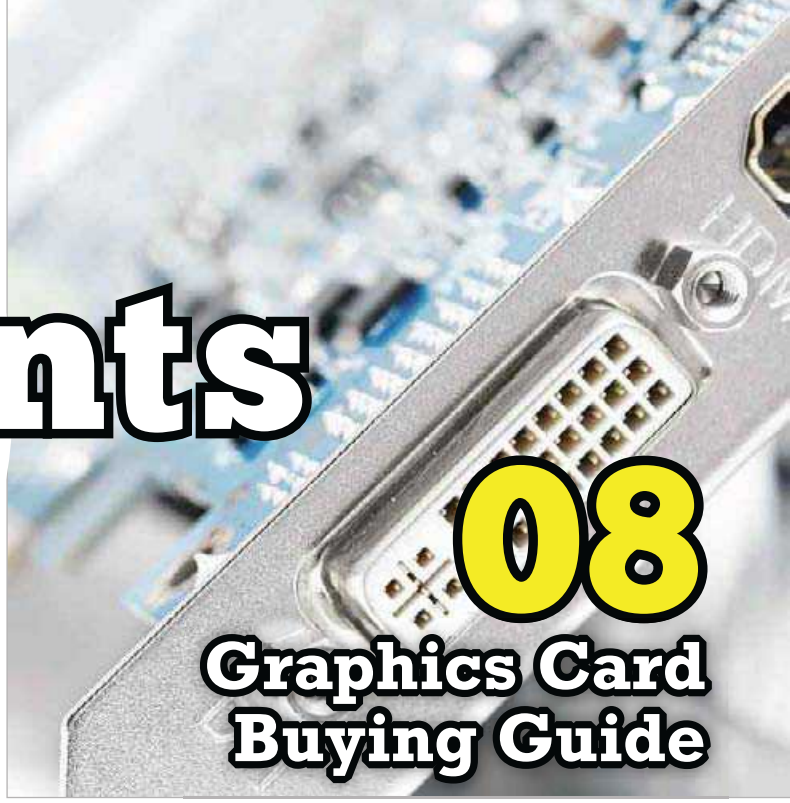

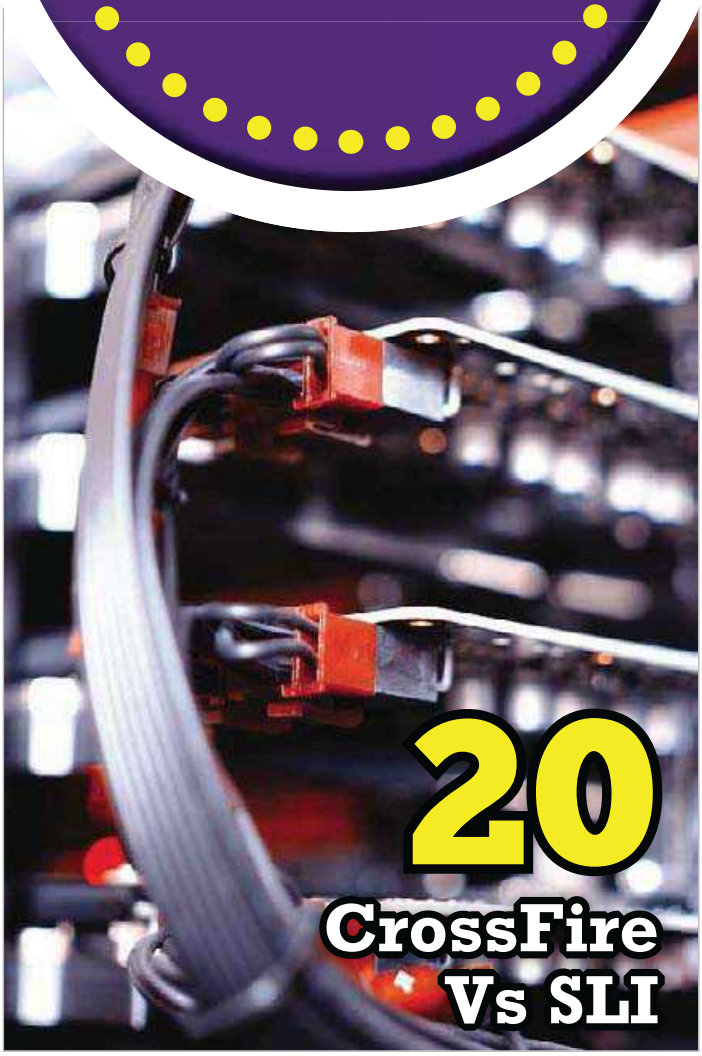

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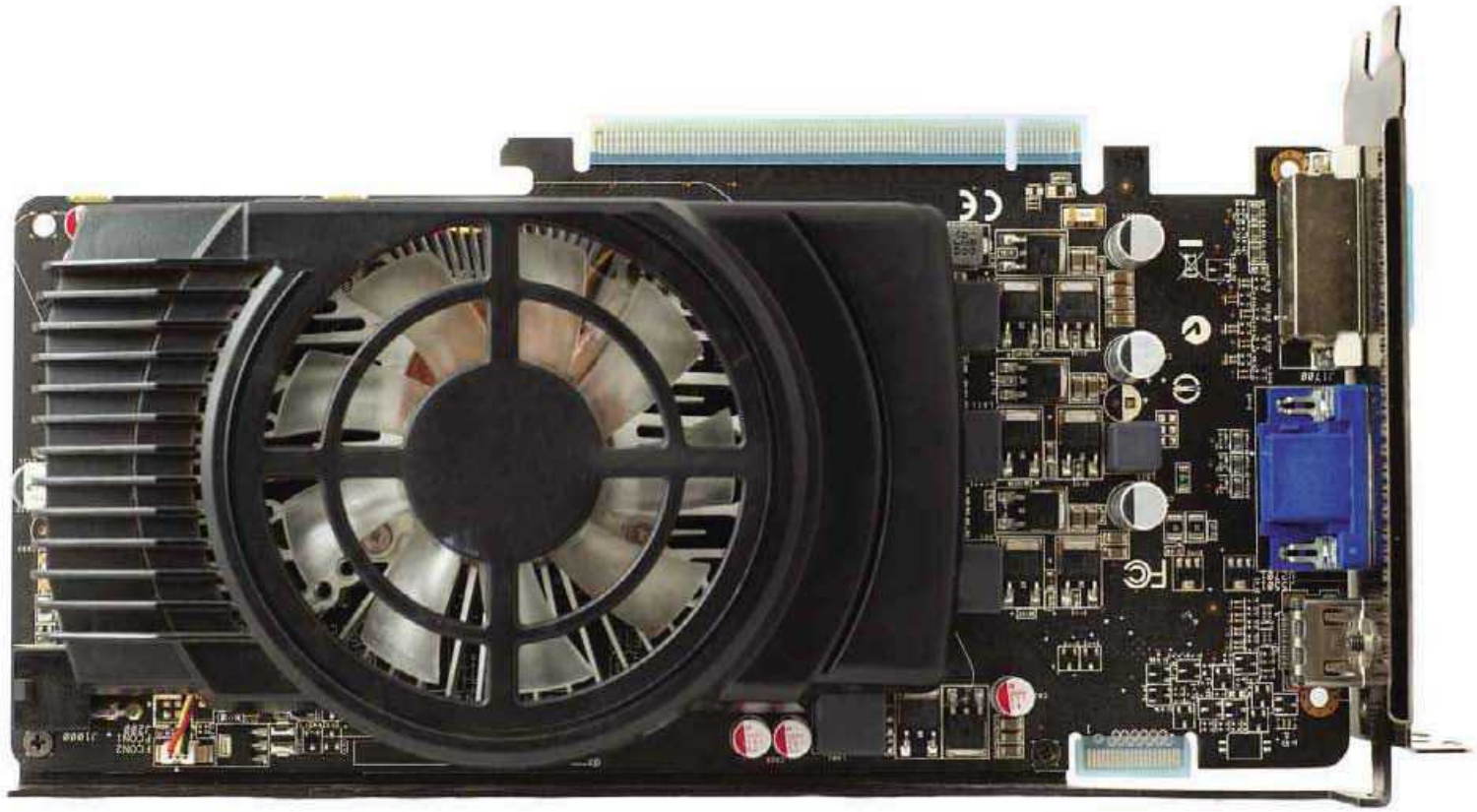


GPU Buyer's Guide

Take a step up from on-board graphics by buying a dedicated card

The market for graphics cards is large and expensive, and in many ways it's similar to the CPU market in having two large companies dominate it and a number of recent generations. But buying a graphics card can be confusing, because generations overlap (and occasionally resurface), capabilities are wildly disparate between similarly named models, and Radeon recently rebranded its entire line, meaning there are still several different numbering systems on the market.

For all those reasons, the best way to make sure you find the graphics card you want is to go right back to the basics and learn how to read the specifications for yourself. And to make sure you can do that to the necessary extent, here are our explanations of graphics card specs and what you need to look for when you're trying to buy a new one.

Picking A Manufacturer

There are two major companies producing graphics chipsets – AMD and Nvidia – and both manufacturers have their own line of cards, each with their own advantages and disadvantages.

As a consumer, the good news is that neither manufacturer is substantially better than the other in any universal way. The bad news is that this means you have to base your choices on lots of small differences instead, as with CPUs, on a couple of big ones.

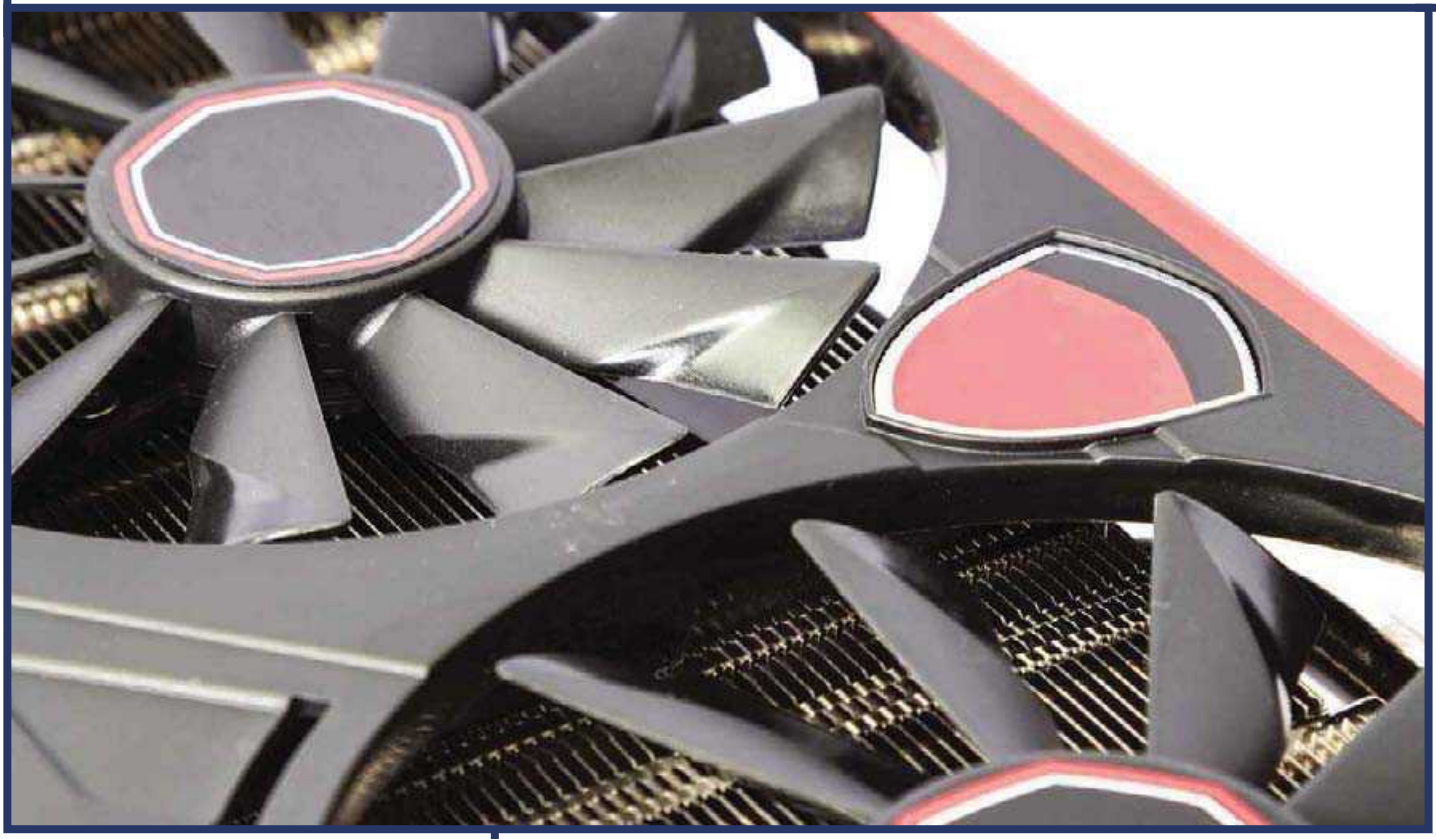
As a general rule, Nvidia cards are slightly faster, but AMD cards are slightly cheaper, so you pay about the same amount for performance. At the point where most consumers are going to look for cards, you could flip a coin to choose and not end up in any major problems. Functionally, performance will be indistinguishable from game to game.

If you're running an AMD-based system already, it's more likely that your motherboard and CPU will have features that can combine with AMD's Radeon graphics cards, and the same is true for Intel systems and Nvidia GeForce cards, but essentially, the two brands are equivalent to one another.

We'll get into the specific technicalities further on in this article, but for now we recommend that you start making your choice based on what the best card you can fit in your budget is. With graphics cards, you can usually squeeze out a fair chunk of extra performance by spending about £30 more, so establishing a point at which you will absolutely not pay any more is the best way to make choosing a card easier. Otherwise you'll end up with a £350 power-draining beast that is nonetheless technically better value than the £150 card you started looking at.

Once you've pinned down the maximum price you want to spend, you can start investigating the actual features of the card instead. Does it have the right ports you want? Does it have one or two fans? Is it double-height or not? Those factors are all more important to you, ultimately, than the manufacturer you choose.

It's also worth noting that the structure



of the graphics card industry is a little unusual. Although AMD and Nvidia design and produce the GPU chips that power their cards, both companies sell those GPUs to other manufacturers, who produce their own versions of the graphics cards based on AMD and Nvidia's specs. The original design of the card is called a 'reference' version, but card manufacturers (companies such as Sapphire, XFX, MSI) may add features not seen on the reference board or, indeed, omit them to save money.

Extra ports, additional fans and factory overclocks are just three things you might get from one manufacturer but not another. So even after you've picked a card model, you may find yourself comparing two competing versions of the same product. In general, the difference between these cards is minuscule. We recommend you stick with a manufacturer you're familiar with unless you have good reason not to, just for peace of mind.

Graphics Card hardware

To select a graphics card, you need to be aware of how the hardware relates to its performance. There are many factors affecting this.

The graphics card's chipset refers to the reference design it is based on. All cards with the same chipset have broadly similar capabilities and can be directly compared with one another in ways that other cards can't. If they have the same chipset, they run on the same architecture, so it's comparatively easy to figure out when one of the cards is better: it's just the one with higher numbers!

> **"If nothing else, it's worth paying attention to the chipset's process design"**

If nothing else, it's worth paying attention to the chipset's process design, which is given in 'nm' (nanometres). As with CPU architecture, the smaller this value, the more energy efficient it is and the faster the GPU can run.

A GPU (graphics processing unit) is the processor of your graphics card and the bit that performs the rendering and calculations for graphics. Most cards quote two speeds: the base clock speed (which the card normally runs at) and the boost clock speed (which it temporarily switches to at times of high load). These values are given in megahertz (MHz), similar to normal CPUs, and dictate the number of updates that the GPU can make per second.

The confusing thing about clock speed is that they can't be directly compared to check performance unless the chipset of the cards is the same. A card with an 800MHz clock speed can be faster than a card with an 1100MHz clock speed if the architecture is sufficiently different!

If the chipset is the same, you can use clock speed to compare card performance to an extent, however. Cards with a higher clock speed perform more operations per second, so it's not uncommon for manufacturers to perform a 'factory overclock' and run it slightly faster than the reference design – particularly if they add extra cooling to increase the hardware's temperature tolerance.

Memory is also important in determining speed. It's something of a misconception that extra graphics RAM will markedly improve performance. Having the minimum amount of necessary RAM available is important, but if you have more than that amount it won't have any real effect, so don't go for 8GB unless you

have good reason. More important is the type of RAM. GDDR5 is faster than DDR3 but also a little more expensive.

RAM bandwidth (which determines the amount of data that can be shifted in a single update) is affected by two factors: the memory clock rate and the memory bus size. Unlike GPU clock speeds, you can compare them across different cards as long as the RAM type is the same. The memory bus size is given in bits, and more bits means better performance. Most modern cards are likely to use at least a 128-bit memory bus, but you may see as high as 512-bit, with performance directly proportional to size.

As a rule of thumb, you can quickly compare available memory bandwidth by multiplying the bandwidth by the clock speed. The bigger the amount that comes out, the better.

Tech Support

As well as the hardware capabilities, graphics cards listings will show the technologies they support, some virtual, some physical. Knowing what they mean will help you decide how relevant they are to you.

For example, all cards will quote, somewhere, which version of the two main graphics APIs they support. The latest version of DirectX is 12 and the latest version of OpenGL is 4.5, though graphics cards still only support OpenGL 4.4 as standard. Don't worry too much if the card you're looking at only supports a slightly older version. Most of the time, this won't result in any notable performance decrease; it'll simply block off access to some of the latest effects and shaders, but it'll take years to go entirely out of date.

Support for multi-card operation – called SLI by Nvidia and CrossFire by AMD – is only of any importance if you plan to run multiple cards in tandem. To run cards like this, the GPU needs to be the same (or have very similar underlying technology), which means that most SLI/CrossFire users buy two cards together. Some low-end cards explicitly will not support SLI and CrossFire, but in general, any card and motherboard at the mid-to-high end of gaming will.

The number and type of hardware interfaces are also worth paying attention to. Here's what you might find on a modern card:

Dual-link DVI-I / DVI-D refers to a DVI interface with extra pins that allow it to reach resolutions of 2560 x 1600, instead of the single-link maximum of 1920 x 1200. DVI-I is a combined analogue/digital port, while DVI-D is digital-only. Your card may have both or just one.

HDMI is a high-definition audio/video interface available in several different versions. The most recent pair – HDMI 1.4 and 2.0 – both support 4K video and 3D video, but HDMI 2.0 is the only to support 4K in 3D. HDMI 1.4 also only supports 24Hz refresh rate for 4K and 3D video, whereas HDMI 2.0 supports the full 60Hz.

Finally, DisplayPort is a video interface designed to replace VGA and DVI. With adaptors, it's backwards-compatible with both ports and can also be used to carry other data such as audio and USB signals.

Usually, it's possible to utilise several of these ports at once – sometimes up to four, depending on how many there are – so check the maximum number of supported screens. Note that some chipsets support more screens than the card can physically accommodate!

Current Models

Selecting the best chipset to look for within your budget means you've always got at least two decent options: one Nvidia and one AMD. It's also important to be sure you're actually getting a substantial upgrade from any integrated technology. So with that in mind, here are the best chipsets at common prices and how they compare to one another.

Budget Cards: Under £80

The GeForce 700-series may have been succeeded by the 900-series, but if you're looking for a gaming-capable budget buy, then the GeForce GT 740 remains your best choice. Specifically, we like the look of the Gigabyte GT 740, with its 1072MHz clock speed, 1GB of GDDR5 RAM, max resolution of 4096 x 2160 and Gigabyte WindForce cooling system. Interfaces include dual-DVI, VGA and HDMI.

The only sticking point is that it's noticeably slower than the AMD equivalent, the R7 250. It does have a significantly lower TDP (65W) making it excellent for low-power systems, but in almost every other way (including price), an R7 250 is better.

Casual Gaming Cards: Under £140

The best Nvidia cards at this price are the GeForce GTX 950, which you can find with 2GB of GDDR5 memory for about £140. The best Radeon cards are the RX 460, which have 4GB of GDDR5 and are slightly cheaper, but also benchmark a lot lower despite their additional RAM.

Released this August, the GTX 950 is a

“Graphics cards listings will show the technologies they support, some virtual, some physical”

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> **As a general rule, Nvidia cards are slightly faster, but AMD cards are slightly cheaper**

cut-down GTX 960 and offers almost as good performance at a much lower price. It uses less power than its AMD equivalents despite performing much better, and it's capable of running even new games in full HD. For this type of use, the RX 460 just about loses out, and when you're looking at gaming, that's enough to turn us off.

Mid-Range Cards: Under £200

Although you can get the Nvidia 1060 3GB at this price, its performance doesn't at all match the AMD equivalent, the RX 480 4GB – but that's what happens if you take half the RAM off a card. The RX 480 is also better than the previous Nvidia card for this price, the GTX 960, which means it's hard to recommend anything other than it. Not only is it a new card, it's priced well, benchmarks higher than the older Nvidia cards in its price range and is the superior or equal to any 3GB version of the GeForce GTX 1060. For cards around £200, there's not really any choice at all.

High-end Cards: Under £300

At the high end, Nvidia's GTX 1060 can redeem itself slightly – at least if you buy the 6GB version, which is priced around £290. AMD's line offers two alternatives: the R9 390 8GB, which is priced bang on £300 and the RX 480 8GB, which is priced around £250-£280. Of those cards, the 1060 performs best, gets you better performance for the money and is effectively future-proof. If you want a better Radeon card, you have to spend well north of £300 (for example, the R9 NANO or R9 Fury) both of which are closer to £400. If you have £300, to spend the GeForce GTX 1060 is the card to get.

Unfortunately the number of different models of card available makes it difficult to be more specific than this, not least because availability varies wildly. Hopefully, though, knowing what chipsets to look for can help you start figuring out which specific card fits your needs. **mm**

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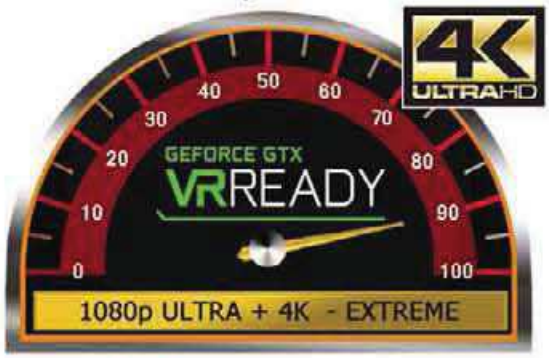

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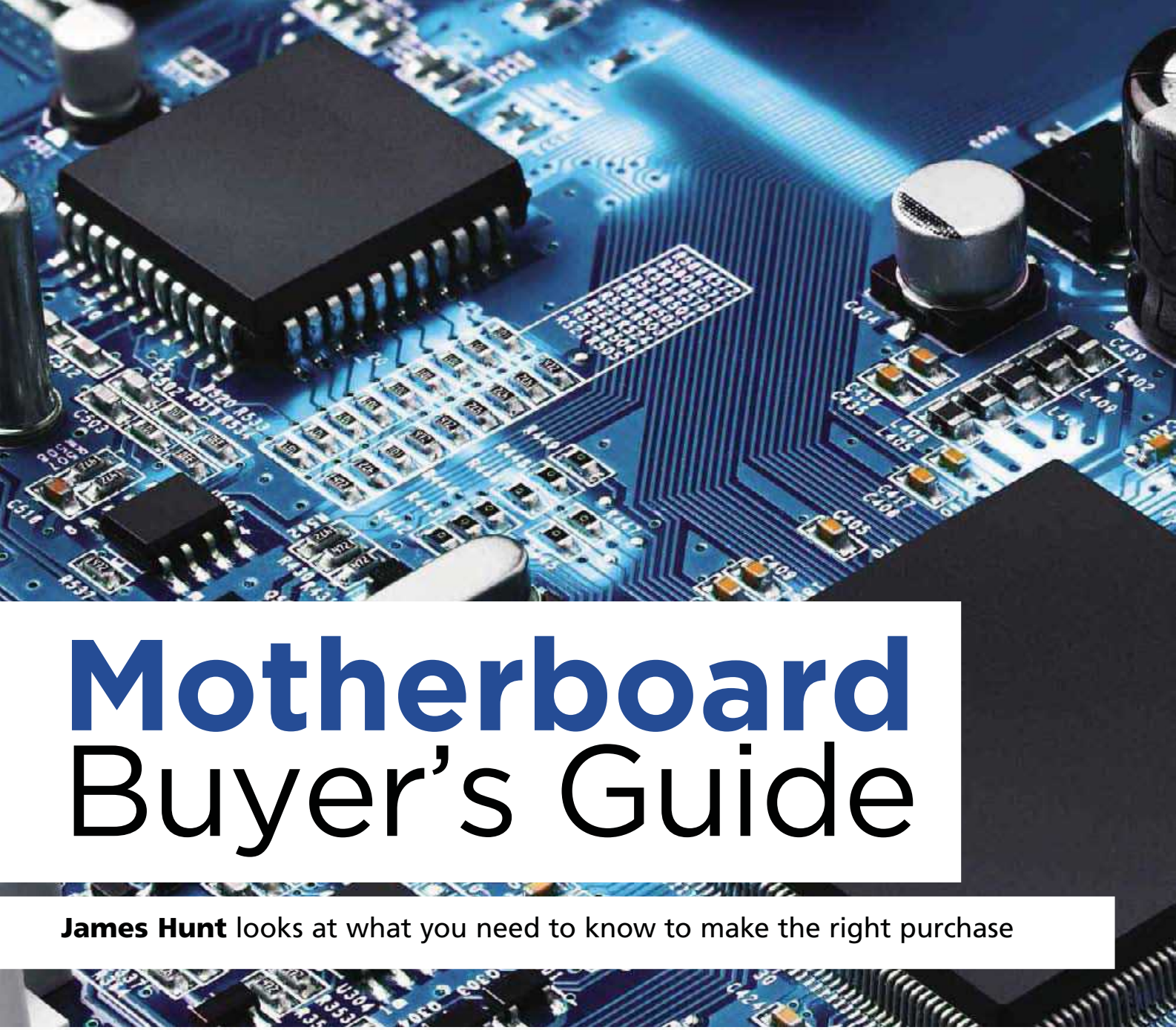


Motherboard Buyer's Guide

James Hunt looks at what you need to know to make the right purchase

As well as unlocking the abilities of your most expensive components, motherboards dictate how upgradable your current system is. Buy the wrong motherboard and you might run out of space for RAM or lose compatibility with the latest processor releases. Upgrading your motherboard isn't just about getting immediate performance improvements; it's about the performance improvements it'll allow you to get in the future.

But what should you be looking for? And what boards are worth getting? Our motherboard buyer's guide will make sure you know all you need to before you start shopping.

Price & Manufacturer

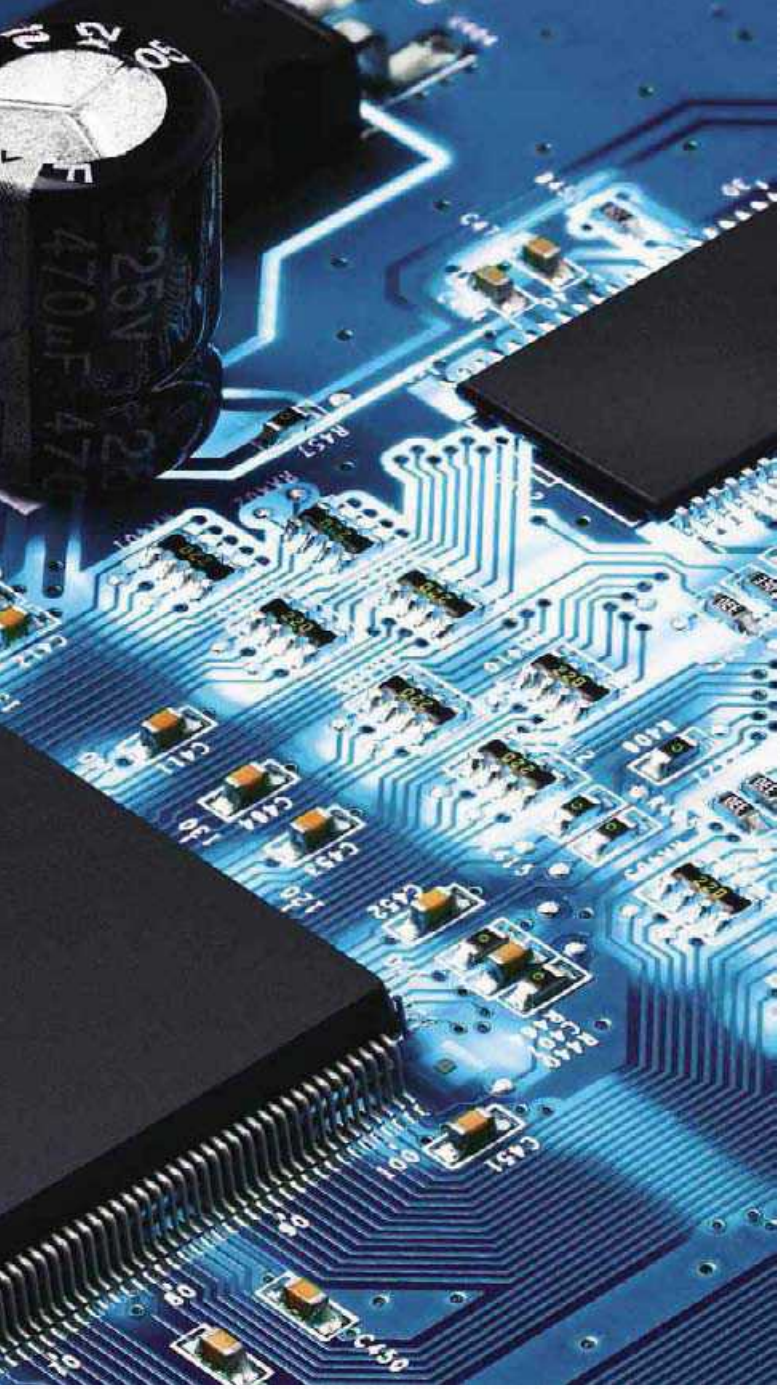
Like graphics cards, motherboards are designed by specific companies (AMD and Intel) and then manufactured by third parties. Again, this means the price and features of individual boards can fluctuate wildly based on the whims of the company putting it together, so you can assume the specs and advice given in these pages refer to the reference designs and may vary slightly.

Motherboard pricing varies fairly widely, from £30 for the cheapest varieties (typically smaller or older models with fewer abilities) to as much as £300 for the most feature packed and advanced boards. That leaves a lot of room to manoeuvre when you're looking for the right one.

If you buy an Intel-based board, then you're unlikely to find anything using the newest chipsets for under £70. If you want something more modern, we'd recommend spending somewhere in the region of £80-£120. Above that, you're buying specialist overclocking- and performance-focused hardware that casual users don't need, but which gamers will be dead set on procuring.

AMD motherboards start just as cheap as Intel's, but top out much lower. You won't find an AMD motherboard more expensive than £200 no matter how hard you try. That makes the sweet spot for current-generation purchases come in a little lower, so if you budget between £60-£90 for an AMD board, then you're sure to get something worth owning.

Once you've decided on a chipset and price-range, you'll then have to decide which manufacturer to go for. In the long term, the difference between manufacturers is reasonably small, since they all manufacture hardware using the same chipset specifications anyway. If you're a casual user who doesn't poke around inside your BIOS or case very much, you can probably base your decision on price alone without anything to worry about.



“You won’t find an AMD motherboard more expensive than £200 no matter how hard you try”

In particular, Intel’s own-brand motherboards are highly recommended for buyers who want to get a good deal on the price, but aren’t interested in flashy design elements or additional features. Pickier users may be interested to know that Asus boards are often considered to have the best balance between features and reliability, but it’s still a slim gap between it and its close competitors, Gigabyte and MSI, so don’t worry if one of the latter manufacturers has a feature (or price) you prefer!

Current Chipsets

There are loads of chipsets on the market, and extensively explaining the abilities of each would see us quickly running out of room. However, we can tell you what the latest generation of boards are, what they’re used for and, crucially, how they relate to previous-generation hardware, so you know how to find your preferred options.

Intel Chipsets

Intel’s motherboard lines over the last few generations have come in six different chipsets. The letter prefix indicates the board’s purpose, and the number following indicates the position in the line. Q and B-prefixed chipsets are mostly aimed at business use, while H and Z boards are aimed at consumers.

The Intel 100-series chipset is designed for use with Skylake CPUs. They were first released in Q3 2015 and, crucially, aren’t backwards-compatible with earlier Intel chips thanks to a revised socket type: LGA1151. They’ve dropped PCI support completely, and while they are capable of supporting DDR4 RAM, many boards still use DDR3.

As ever, there are six different chipsets in the series, all of which are grouped together under the ‘Sunrise Point’ codename:

H110 will be the budget consumer chipset, with fewer PCIe lanes than the others – just six, all of which are PCIe 2.0. It will only have four SATA 6Gbps ports, no SATAe or PCIe M.2 support, up to four USB 3.0 ports and up to ten USB 2.0 ports. Previous H-series boards had a limited number of DIMM slots, no overclocking support, no SLI graphics support and no extra features like Intel Smart Response SSD caching, so expect a similar stripped-down approach when the H110 comes to market. Its previous-generation equivalents are the Haswell H81 and the Ivy Bridge H71.

B150 motherboards are out now and break with Intel tradition in being aimed at gamers as well as business users. The B150 has eight PCIe 3.0 slots, six SATA 6Gbps ports, up to six USB 3.0 ports, up to 12 USB 2.0 ports and no PCIe m.2 support. They’re largely aimed at budget users and again don’t support overclocking or SLI. The previous equivalents are (loosely) the Haswell B85 and the Ivy Bridge B75.

Q150 motherboards are aimed at business users and due for release later this year. They’ll be similar to B150 boards but support two more PCIe lanes, two more USB 3.0 ports and two more USB 2.0 ports. Its Haswell equivalent is the Q85, and the Ivy Bridge equivalent was the Q75.

H170 boards are out now and aimed at mainstream PCs, replacing the Haswell H87, Devil’s Canyon H97 and Ivy Bridge H77. They support 16 PCIe lanes, allowing for SLI mode graphics, six SATA 6Gbps ports, up to two SATAe ports, eight USB 3.0 ports, 14 USB 2.0 ports and two PCIe m.2 ports. Anyone building a standard home PC based on Skylake should start by looking at this line, The price is around £70-£100, making it quite reasonable.

Z170 boards are out now and aimed at gamers and enthusiasts. The business-focused version, the Q170, will follow later this year with similar specs. These boards have 20 PCIe 3.0 lanes, six SATA 6Gbps ports, up to three SATAe ports, up to ten USB 3.0 ports and up to 14 USB 2.0 ports. They also support up to three PCIe M.2 devices. The Z170 succeeds the Devil’s Canyon

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Z97, Haswell Z87 and Ivy Bridge Z77 with a complete set of features and full overclocking support. The Q170 doesn't support overclocking, but has extra enterprise features. If you want a high-end system for business or pleasure, these are the boards to look out for.

AMD Chipsets

AMD's APU chips, which combined a CPU and GPU (like Intel Core chips) require a Socket FM2 or FM2+ depending on their generation. The current generation of Kaveri chips (including the Godavari refresh) use Socket FM2+, and their successor may also use this hardware. Socket FM2+ also accepts older Trinity and Richland chips, but not the first generation of APUs (Llano) which used Socket FM1.

The upshot of this is that if you're buying a new AMD motherboard, you're probably buying an FM2+ board. They have the most potential for upgrading and can accept at least one generation of older chips and may yet support the next version (AMD has announced it'll be around until 2016 at least).

There are four main lines for AMD's A-series chipsets, all of which can support Godavari features (though some may require a BIOS update to enable the newest abilities.)

The A58 motherboards are entry-level FM2+ boards, recommended for use with A4 and A6 APUs. They support dual-graphics (meaning an APU and compatible graphics card). Technically, the A58 has been replaced by the A68H, meaning A58 boards are very cheap. They're commonly cut down, with two DIMM slots, one PCIe 3.0 slot, one PCIe 2.0 slot and USB 2.0/SATA 3Gbps. Solidly last-generation stuff. They may suit budget system builders and those putting together compact systems, but at this point they're largely to be avoided outside of a specialist context.

A68H boards are a safer bet, aimed at home users with moderate needs. They're also designed to be paired with A4 and A6 APUs, with the same dual-graphics ability as the A58, but they also have native support for four SATA 6Gbps ports and two USB 3.0 ports.

A78 motherboards support PCIe 3.0, have a native six SATA 6Gbps ports and four USB 3.0 ports. They're designed to operate with A8 and A6 APUs and even support limited levels of overclocking, making them a good choice for casual gamers.

A88X boards are at the top of the heap, though. They support full CrossFire multi-GPU systems and full overclocking of the A10 and A8 chips they're designed to pair with. They also support advanced storage, like RAID and have four USB 3.0 ports, ten USB 2.0 ports and six SATA 3Gbps ports.

If it looks like AMD's motherboards don't quite match up to Intel's, that's largely because they're older – though keep in mind that they're also cheaper even at the high end. AMD's next refresh isn't due for a good six months yet and maybe even longer. The company's plans are deliberately foggy, at this point.

If you're after an AMD motherboard, the A88X is the only one we can really recommend, mainly because it's the only one that comes close to Intel's offerings. But it's still quite far out of date by those standards, and when you're buying a new system or upgrading an existing one, it seems like a bad call to buy hardware this near to the end of its shelf life.

Ultimately, it's fair to say that buying the perfect motherboard isn't easy, but buying one that works is, so don't get too hung up on the specific differences between very similar models. As long as your hardware fits into it, you'll get by on basically any motherboard. But knowing enough to make an informed choice means you'll never have to pay for features you don't need or can't use.

Intel Motherboard Deals

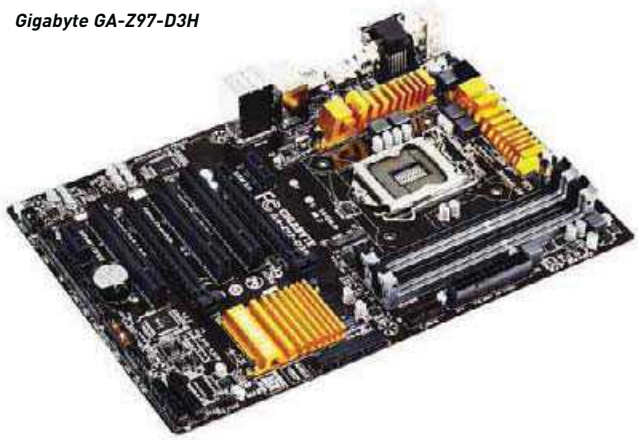
Budget: Gigabyte GA-Z97-D3H (£60)

Gigabyte's Z97 motherboard is as cheap as Socket 1150 boards come if you don't want the inconvenience of a micro-ATX board. And if you're building a desktop PC, we'd always recommend going for the full ATX size, if only so you can fit in expansions further down the line. This board is a Z97 chipset, which means it's also capable of supporting chips all the way up to a Core i7 as long as it's Haswell, complete with overclocking features. For us, that's worth the £15 extra you'll pay over a less-capable Haswell motherboard because of the future-proofing it offers, but if you don't mind a stripped back PC, look for an H81 board instead –

> **"If you're building a desktop PC, we'd always recommend going for the full ATX size"**

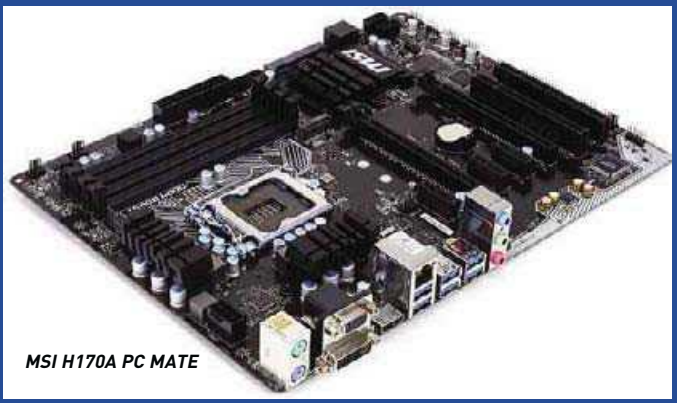
ASRock Fatal1ty Z170 Gaming K6

Gigabyte GA-Z97-D3H

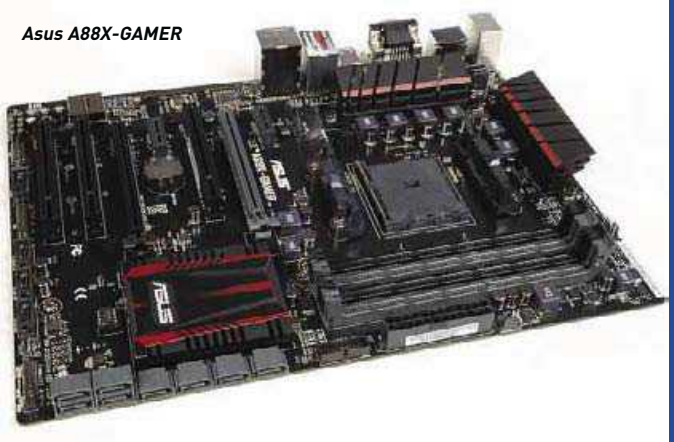


Gigabyte's cheapest is the GA-H81M-H, and that's a solid choice too at £36.

Mid-Range: MSI H170A PC MATE (£85)
Intel's H170 boards are aimed at mainstream PCs, broadly replacing the Ivy Bridge H77, Haswell H87 and Devil's Canyon H97. Although considered mid-range boards, their support for high-end features is more than enough for most home users, with up to 16 PCIe lanes (allowing for SLI mode graphics). This particular board has six SATA 6Gbps ports, M.2 and SATAe ports, built-in HDMI, DVI-D and VGA, eight USB 3.1 ports and four USB 2.0 ports, built-in gigabit LAN and support for DDR4 memory. As long as you don't want to overclock your CPU, this is as good a motherboard as you can get and perfectly pairs with any (locked) Core i5 chip.


MSI H170A PC MATE


Asrock FM2A78

Asus A88X-GAMER


High-End: ASRock Fatal1ty Z170 Gaming K6 (£135)
There are more expensive motherboards around, but the ASRock Fatal1ty Z170 gaming board is enough for most home systems. As well as all the features of the H710 chipset, the Z170 supports full overclocking of both CPU and RAM, and the ASRock Fatal1ty line features gold-plated connectors to facilitate electrically clean and high-quality connection between components. Of particular note is its dual BIOS, which allows you to have a backup BIOS spare in case of an upgrade disaster – an essential feature for anyone who likes to keep their board on the cutting edge of firmware updates. Remember to double-check which board you're buying, though; some cheaper versions of the Fatal1ty actually use DDR3, which is an option for Skylake systems, just not the best one if you're trying to build something high end!

> **"The price and features of individual boards can fluctuate wildly"**

AMD Motherboard Deals

Budget: ASRock FM2A78 Pro4+ (£66)
If you're buying an FM2 or FM2+ chip, it's hard to find a board cheaper than this without resorting to undersized examples. The ASRock FM2A78 Pro4+ is pretty standard, with four DDR3 DIMM slots, triple monitor support and on-board gigabit LAN. It has three PCIe slots and dual-graphics support, with five SATA 3.0 ports. The only area it's even slightly lacking is in USB support, because the A78 chipset only has three USB 3.0 ports by default, with the rest being USB 2.0. Overclocking support is limited, but it's available, and that's enough to avoid the extra expense of a more capable board if you're trying to build a budget system. The only reason we wouldn't go cheaper is because you're going to need space for RAM, and this being a DDR3 board, you can (and should!) reuse your old DIMMs in it.

Premium: Asus A88X-GAMER (£88)
The A88X chipset supports full overclocking on AMD chips and is the ideal choice for anyone building a high-end AMD-based system – at least for the moment. We should once again point out that the forthcoming release of Zen and AM4-socket chipsets means this FM2+-based setup is on its last legs (it still supports DDR3 rather than DDR4, after all), but if you can't wait, it's the one to go for. Overclocking aside, The features in this board aren't far beyond the ASRock board we just looked at, but it does have eight SATA 3.0 ports, four USB 3.0 ports and ten USB 2.0 ports, as well as optical audio out. You don't need to spend any more on an AMD board right now – and, to be honest, you'd struggle to! **mm**

SLI VS CROSSFIRE X

Which multi-GPU solution offers the greatest returns?

Trying to keep your PC's graphics capabilities up to date can sometimes feel like being stuck on a treadmill. Most graphics cards remain competitive for a year or two before they need replacing, and unless you have a huge amount of disposable income, the best graphics will always remain a few steps ahead of your financial capabilities, tantalisingly out of reach.

But if you're looking to improve your PC's graphical capabilities and don't want to spend several hundred pounds on the latest card, or if you have that money but want to know if there's a way you can spend it more wisely, a dual-card graphics configuration might just be the answer.

Nvidia SLI

SLI is Nvidia's proprietary technology, which allows up to four GPUs to act as a single device, sharing the load between them. The abbreviation stands for 'Scalable Link Interface', but that's not particularly important. What matters is that it can vastly improve the speed and quality of gaming at a much lower cost than buying a new high-end card.

Contrary to a popular misconception, SLI configurations don't require the exact same brand and model of card to be used – just that both of the cards use the same GPU and have the same amount of RAM, though the clock speeds can be different. What this means is that you can run two different implementations of a card in SLI, regardless of manufacturer or capability.

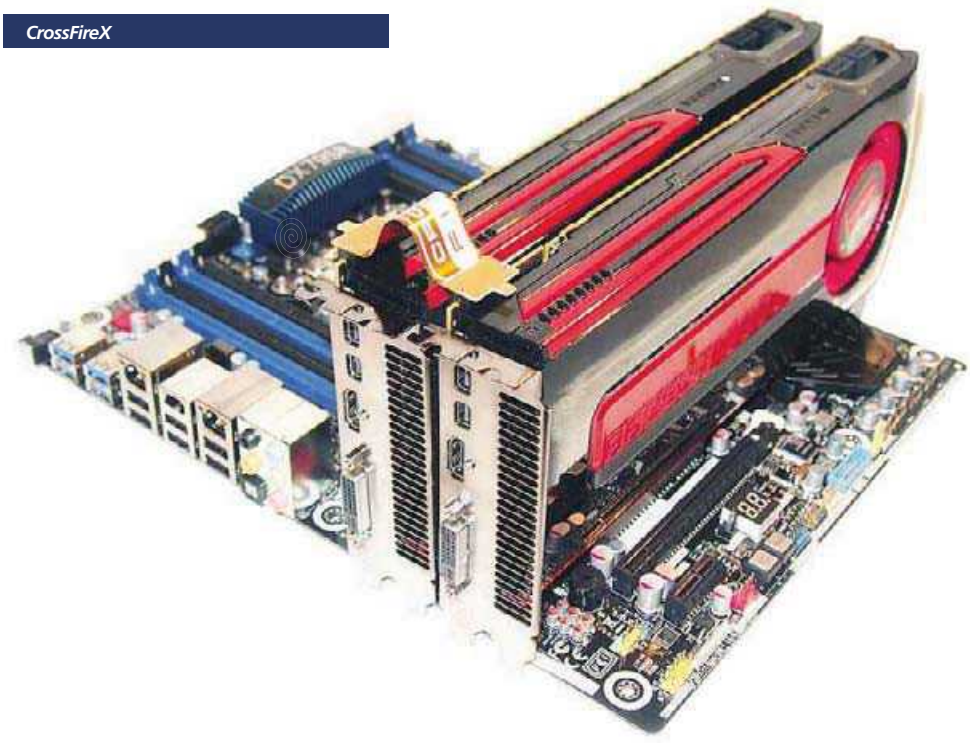
Before you start, it's important to make sure that your PSU has the necessary power requirements to run two graphics cards simultaneously. Insufficient or poor-quality power supplies will result in instability and could even potentially damage your components. If you're unsure what the power requirements are for running two cards together, you can use the OuterVision Power Supply Calculator (**outervision.com/power-supply calculator**) to find out how much wattage your system needs and how big a power supply you should install to meet those needs (remember to get a PSU with around 30% higher output than your system requires, to account for inefficiencies and aging.

Before installing your cards, check on the motherboard where the PCIe 16x slots are. The top one is usually the fastest, but if you have a second PCIe 16x slot, it may be the third one down rather than the second. This is to allow room for dual-height graphics cards, which take up the space of the slot below them, rendering it unusable.

Although performance can differ wildly between different GPUs, models and manufacturers, it's generally accepted that Nvidia SLI offers a

> **"Multi-GPU configurations aren't magic bullets and have the potential to introduce problems"**

CrossFireX



slightly better performance increase over CrossFireX, especially at higher resolutions – but that's not to say CrossFireX doesn't have advantages of its own. Which you choose should ultimately depend on which card you think is most worth buying, as the two are usually quite close in performance, with no major reason to suggest one over the other.

CrossFireX

If you're using AMD cards, you're also able to run multiple graphics cards as a single multi-GPU device, although rather than being called SLI, the technology is known as CrossFireX. CrossFireX allows for configurations of up to four GPUs to be used together on up to four separate graphics cards.

Like SLI, best practice is to use two cards of the same model and brand, but CrossFireX is a little more flexible, allowing you to combine multiple different GPUs of different brand and models. There are some restrictions: the GPUs must be from closely related lines and they will all run at the clock speed of the slowest card. But in general you have a greater range of options with CrossFireX than with SLI.

Perhaps the most interesting thing is that the GPUs don't even have to be on individual graphics cards. If you're running an AMD Fusion APU as your system processor, the on-board GPU can potentially be used as part of the CrossFireX configuration too, as long as you're using a motherboard with the necessary support.

Once you have two or more GPUs as shown on the chart, you simply need a CrossFireX-compatible motherboard and the external CrossFireX connector, which should have been included with the motherboard. This plugs into the side of both cards to allow them to communicate with one another directly (there may be space for more than one, in which case it's advisable, but not required, to use both).

As with SLI, you'll also need to ensure you have enough power to run both cards, your CPU and any other components that are plugged in. If you're unsure, you can use OuterVision Power Supply Calculator to see what your requirements are.

Testing whether CrossFireX has improved performance can be done by playing the games and looking for a jump in capabilities or by running benchmarks and verifying that the numbers show a performance increase.

Compared to SLI, CrossFireX has a few advantages. The ability to use different GPUs makes it easier to create a configuration in the first place, since you can stagger your purchase of the hardware or pick up a second cheaply in a few months from a much larger selection. CrossFireX configurations also have better multi-monitor support. SLI will only run on up to three monitors at once, while CrossFireX can run on an essentially unlimited number, regardless of the resolution and display size.

General Problems

Unfortunately, multi-GPU configurations aren't magic bullets and have the potential to introduce problems as well as improvements.

Above all else, remember that using two GPUs together doesn't mean speeds twice as quick as a solo configuration. Indeed, it's definitely not that fast, because the two cards must use some amount of processor time just to communicate and synchronise their output with one another.

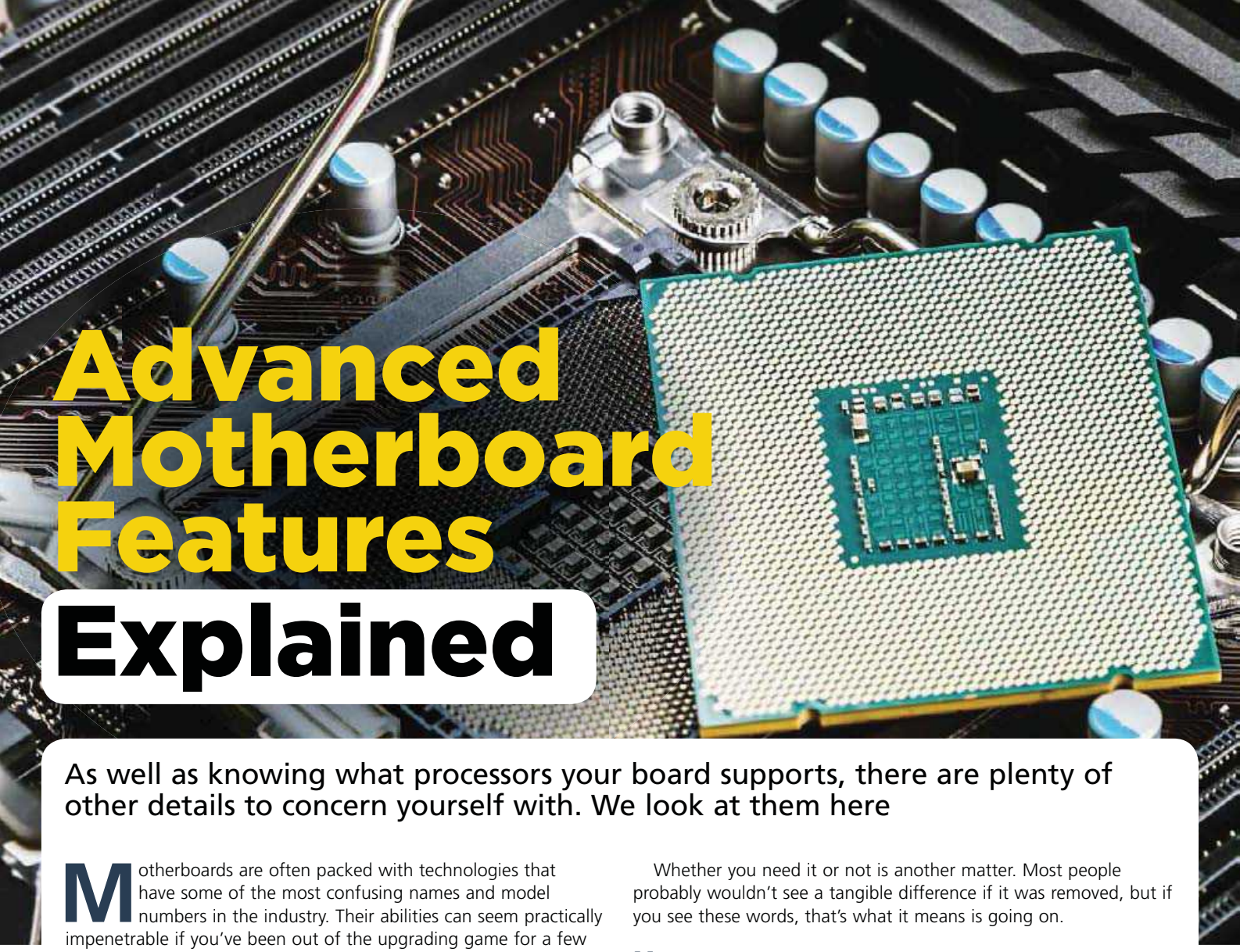
In the best-case scenario, multi-card setups will be about 80% quicker than a solo-configuration. In the worst-case, they might actually be slower than a single card (when the improvement they offer is lower than the multi-GPU processing overheads). Most gamers will see around 30%-50% improvements across the board, but there are no guarantees.

Poor multi-GPU performance is most often seen at low resolutions, when a single GPU is already capable of running at or close to full-speed. The higher the resolution, the better chance you have of seeing a gain from a multi-GPU setup.

Multi-GPU systems also place other constraints on a system. The extra heat generated by an additional graphics card (or two or three!) means that cases may require extra exhaust fans to keep temperatures low. Extra fans (including the graphics cards' on-board fans) also generate a significant amount of extra noise, so fans of quiet systems should be advised that there's no such thing as a quiet multi-GPU system!

Despite these problems, running multi-GPU PCs is generally a good idea if you can afford it. Two mid-range cards are almost always better than a single high-end card costing the same price, and while there are potentially extra financial requirements involved in buying a better PSU or new cooling components, these are good investments for the health of any system and are likely to pay off in the long term. **mm**

Nvidia SLI



Advanced Motherboard Features Explained

As well as knowing what processors your board supports, there are plenty of other details to concern yourself with. We look at them here

Motherboards are often packed with technologies that have some of the most confusing names and model numbers in the industry. Their abilities can seem practically impenetrable if you've been out of the upgrading game for a few years and, for that matter, even if you haven't.

Rather than leave you to try to guess what features are good and why, we've looked at some common motherboard abilities and explained why they're important and what they might mean in practical terms – everything from the most basic to the most advanced…

Sockets

The type of socket in a motherboard determines what chips can fit into it and almost nothing else. For example, the current generation of Intel chips (Skylake) require motherboards with Socket LGA-1151 compatibility, otherwise the CPU won't physically fit. Socket LGA-1151 may also be referred to as simply Socket 1151 or Socket H3. For AMD chips, you have a choice of Socket AM3+ or FM2+, though Socket AM4 is due soon.

The only slight exception to this rule is that the size of the socket can also determine the type of cooling that is compatible with a motherboard. All the Intel sockets at least as far back as 2009's LGA-1156 have been the same shape, which means that cooling systems designed for those chips are still compatible with all current Intel chips. Socket AM4 may be backwards compatible with Socket AM3/3+ coolers – though at this point it's too early to say!

Intel Turbo Boost Technology

Turbo Boost is a feature available in some Intel chips, and if a motherboard supports it (which any using Intel chipsets should), it means the processor's clock speed can be increased to take advantage of high resource demand. It's sometimes referred to as 'dynamic overclocking'. The main difference between this and actual overclocking is that the chip decides based on very conservative estimates what it can cope with.

Whether you need it or not is another matter. Most people probably wouldn't see a tangible difference if it was removed, but if you see these words, that's what it means is going on.

Memory

All motherboards support some amount of RAM, but there are a few things you need to understand about whatever board you buy.

First of all, check whether it's DDR3 or DDR4. The latter is faster and uses less power, and it's the standard going forward (although AMD hasn't adopted it yet). A DDR3 board isn't completely useless: it means you can upgrade without buying new RAM, for example. But it isn't recommended if you can avoid it.

The number of DIMM slots is also worth checking. Small and cheap motherboards may only allow for two DIMMs, limiting the amount of memory that can be inserted. Larger boards should have space for four DIMMs.

Intel XMP

Like Intel Turbo Boost Technology, XMP ('Extreme Memory Profile') is a technology that allows your BIOS to automatically configure the speed and voltage timings of your RAM for optimal performance. Again, most users won't notice it, but it does mean that whatever RAM you put in your motherboard will automatically perform as well as it can without any user intervention required.

Integrated Graphics Processor

Certain types of CPU (for example, AMD's APUs and almost all of Intel's current chips) have a GPU coprocessor, which removes the need for a separate graphics card. But the technology has to be on the motherboard as well, otherwise the GPU coprocessor can't do its thing. Most modern motherboards do support integrated graphics, but it's worth making sure if you plan to use it.

The integrated graphics specs may reference 'shared memory'. For reference, this means that the GPU (when active) will section

off part of the system's total RAM complement to use as graphics memory – usually up to 512MB. Graphics cards, of course, have their own RAM on board.

SLI / CrossFireX Support

High-end motherboards tend to support SLI and CrossFireX, both of which are multi-GPU technologies (the former for Nvidia, the latter for AMD). Support for the technologies means you can put multiple graphics cards into your system (space and power permitting!), then use them to get high-end graphics performance at lower prices than a single high-end card would cost.

Notably, some chipsets support up to four-way SLI and CrossFireX, though it depends on the number of PCIe slots available as to whether you can take advantage of that many cards simultaneously.

Expansion Slots

The 'expansion slots' are the bits on your motherboard that allow you to plug in extra cards. These days, that tends to mean things like graphics cards and wireless network cards. You may not even have any!

A modern motherboard should have at least one PCIe 3.0 slot capable of x16 bandwidth, which is the one you should use for your graphics card. Further available slots may be x4 or even x1, though in most cases this makes no difference. It's worth remembering that dual-height graphics cards can occupy two slots, so if you only have a small number on the motherboard, subtract one from the total number!

SATA ports

Storage devices like SSDs and optical drives use a SATA (Serial ATA) connection. The latest revision is SATA 6Gbps, though some motherboards – especially older ones – may have SATA 3Gbps ports. Six in total is not unusual, though you may find motherboards with more or fewer.

"Most modern motherboards do support integrated graphics, but it's worth making sure if you plan to use it"

M.2

An alternative SSD connector, M.2 ports are more like PCI slots in that the SSD plugs directly into them. M.2 ports are significantly faster, but SSD speeds are already so good that you're unlikely to notice a huge difference. Don't worry if your motherboard doesn't support M.2. As a more expensive feature, it's only on high-end boards at this point.

RAID

Not every motherboard supports RAID, and those that do may not support all RAID types. RAID means 'Redundant Array of Independent Disks' and can speed up access to hard drives (especially mechanical hard drives) and/or improve data integrity by providing multiple copies of the same data.

There are several types of RAID array, most of which aren't of any interest to casual home users. They're mainly aimed at people running multi-user systems, where access to a single set of data is conducted on a single machine. Don't worry if your motherboard has limited RAID support; you almost certainly won't use it.

Intel Rapid Storage Technology

If you see this listed as a feature, note that it's used by drives operating in RAID mode. Again, if you're not using RAID, you won't lose out by not having the feature available. If you are using RAID, the IRST settings can tell you if anything is wrong with the array when your PC boots, before it gets accessed.

LAN / Wi-fi

Most motherboards have on-board gigabit Ethernet, which gives a 1000 megabit connection over a compatible LAN. If you don't plan to use a network cable, there's no need for this. On-board wireless is rarer on

motherboards, but if it is available, make sure you get Wireless AC (802.11ac), because that's the current wireless standard. If you plan to add a PCI network card or USB network adaptor, you don't need to worry about on-board wireless.

Realtek Audio

Realtek makes audio chipsets, which are commonly used to provide the on-board sound for motherboards. If your particular board doesn't have Realtek audio, it probably has another kind instead, but this is the most common. Features you should look for include jack detection (which, as the name suggests, detects whether something has been plugged into your audio ports) and multi-streaming, which allows you to listen to two different audio sources on two different speaker sets.

USB ports

If you're this far through an issue of Micro Mart, we can safely assume that you know what USB ports are. USB 3.0 ports are blue and have a higher data rate than USB 2.0 ports, which are grey. The number of total ports may not be directly reflected by those on the back panel, though. You may have to connect extra front-panel or expansion slot devices to the USB headers on your motherboard to take advantage of all the ports.

On the most modern boards, you may also find a USB 3.1 port. USB 3.1 Type A looks like a normal USB port but has a red or teal interior, while USB 3.1 Type C is a smaller port most commonly seen in phone chargers. USB 3.1 has double the bandwidth of USB 3.0. Version 3.1 can transfer 10Gbps, Version 3.0 can do 5Gbps and Version 2.0 just 280Mbps.

USB 3.1 also supports 4k video output and could, potentially, replace the likes of HDMI and DisplayPort in the future. It's not required, but it's certainly a useful addition if your motherboard supports it.

Form Factor

Motherboards come in any shape and size you like – as long as you like one of the few that exist. Despite the number of board manufacturers that there are, motherboards all fit into just a few size categories to make sure it's possible to fit them into a standard case.

This is expressed as one of the following classes:

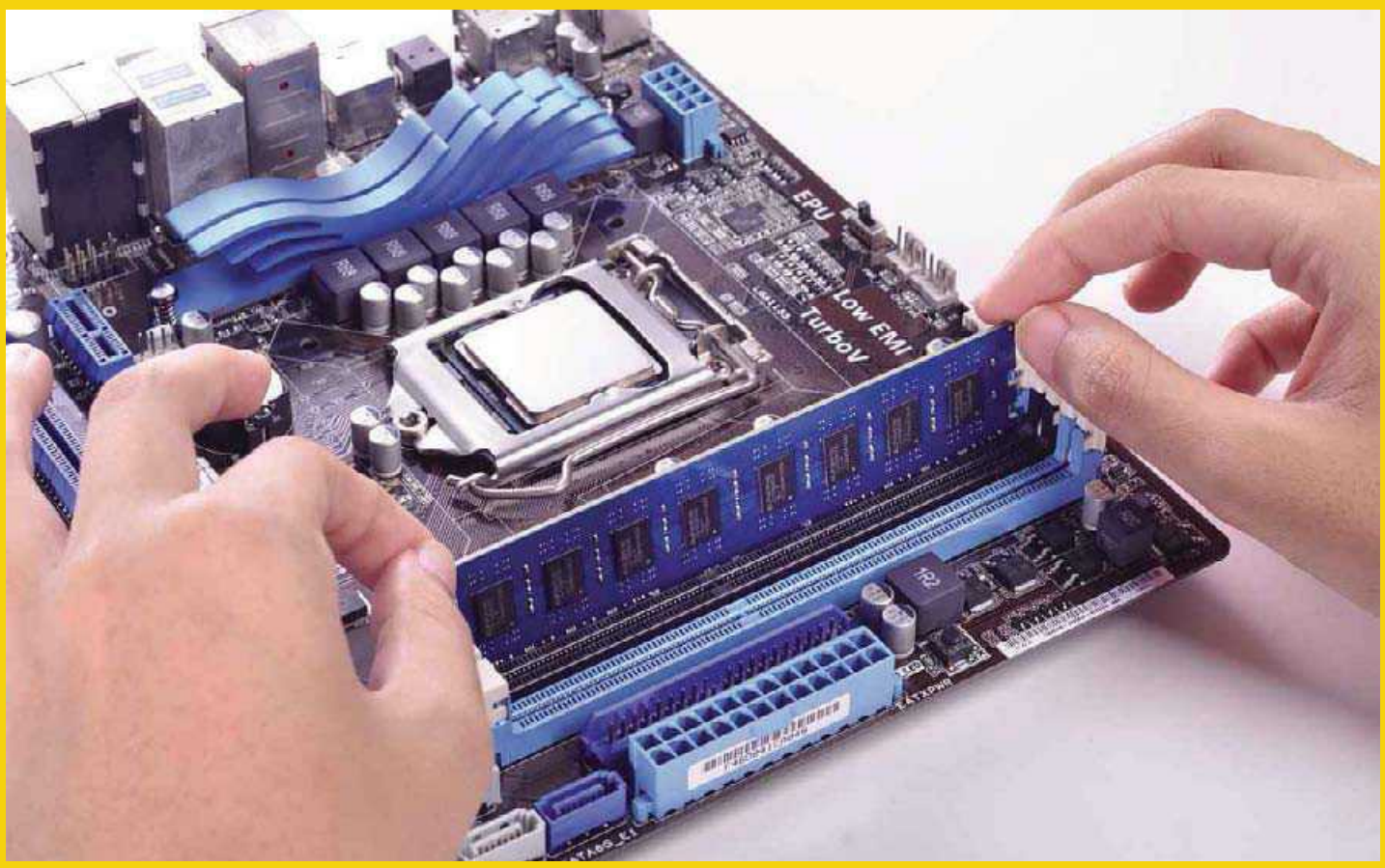
Mini-ITX, the smallest and most compact type. These may be severely stripped down to the point of having only a single expansion port or room for just two DIMMs. They're aimed at the smallest PCs only and tend to require a specialised case.

Micro-ATX boards have slightly better abilities and are a little larger, to the point where they can fit in standard ATX cases, but they still lack a large number of features and are designed for smaller cases and/or low-end systems.

ATX boards are the standard choice in a desktop PC. If you're aiming for a high-end system, get an ATX board with robust overclocking features and plenty of support for cooling expansions. You should expect at least five expansion slots and support for four DIMMs simultaneously.

S/PDIF

This acronym stands for 'Sony/Philips Digital Interface Format' and is a type of digital audio interface used by many manufacturers,



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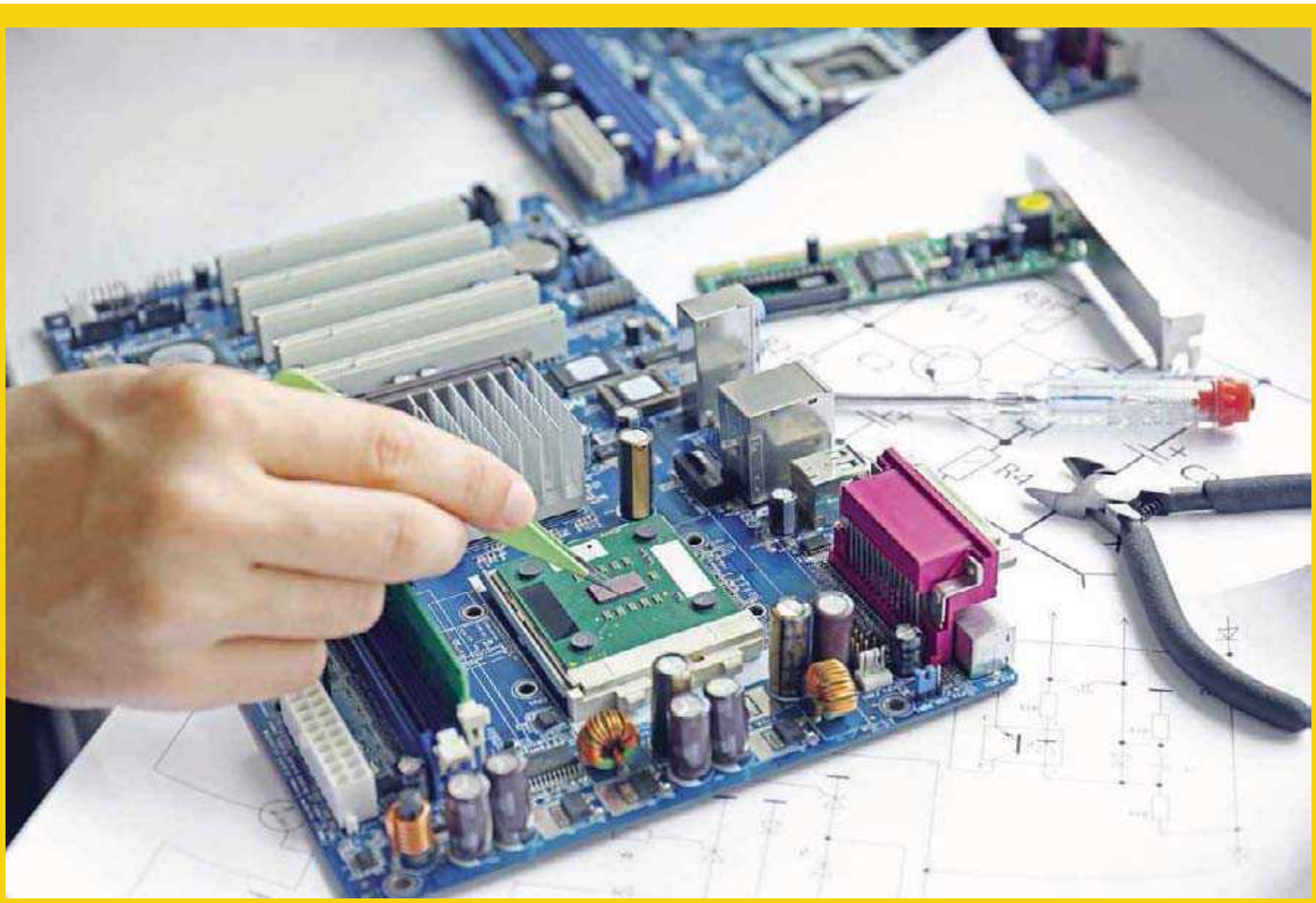

> **“The ability to flash your BIOS is helpful if you’re trying to add new features to your PC for free”**

although it was developed by Sony and Philips. The cables can be standard coax or fibre optic and, for that reason, might sometimes be called fibre optic out. If the board supports this format with its on-board sound, you’ll probably find the telltale square-ish port on the back panel. If you don’t, it means you can still attach S/PDIF directly to the motherboard using the three-pin interface on the motherboard itself (assuming, of course, you have a sound card or expansion card that supports it!)

TPM Module

A TPM Module is (somewhat redundantly) A Trusted Platform Module. Motherboards with TPM support can have a TPM module attached, allowing hardware to be secured and giving applications access to encryption.

TPM modules give hardware the ability to use powerful encryption, which prevents unauthorised interception of data. Some motherboards even have a TPM module built in. Again, support for this technology doesn’t need to be available, but it doesn’t hurt if it is.

DualBIOS

The ability to flash your BIOS is helpful if you’re trying to add new features to your PC for free, but it also has the potential to go completely, horribly wrong. A mis-flashed BIOS on your motherboard probably means your computer won’t even start so you can fix it.

DualBIOS (and similar technologies) mean you have a pair of ROMs on your motherboard instead of the usual single BIOS ROM. If anything goes wrong, you can simply switch to the other and boot from that. Having two BIOS systems in a PC is inefficient, so few manufacturers offer this feature. If yours does, you’ll find a hardware switch by the BIOS so you can change which is being used.

UEFI BIOS

The Unified Extensible Firmware Interface is a replacement for the standard, old-style BIOS. Windows 8 and 10 PCs can take advantage of the new system. UEFI BIOS systems incorporate things like mouse support and graphical interfaces, whereas old-style BIOS are very text-heavy and can only be used with a keyboard.

UEFI also has a lot more beneficial abilities: it’s 64-bit enabled, architecture-independent and supports disks far larger than the standard boot record. Indeed, the upper limit of UEFI is 9.4 zettabytes, so it’s unlikely you’ll get past that barrier anytime soon!

Hopefully, you now know a bit about the kind of technology your next motherboard is likely to support, and whether you’re the sort of person who’ll need them or not. Either way, it’s nice to know in advance – if only so you don’t get fleeced for motherboard features you’ll never use. RAID, we’re looking at you… **mm**

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OVERCLOCKING YOUR GPU

It's not just your CPU you could be getting more from!

Just as overclocking your CPU can help you inch your gaming performance ahead slightly, overclocking a GPU is one way to squeeze extra frames out of a graphics card, whether that's because it's starting to flag with age or because you know it can do better than the manufacturers think is fair.

Of course, overclocking your graphics card isn't a free pass to superior performance. Performance improvements can be minimal even when you get them and, as with all kinds of overclocking, you have to take care with what you do otherwise you can physically damage your graphics card. It's not for the faint-hearted, and it's worth pointing out that any advice we give here should only be followed if you're comfortable knowing that you risk breaking your card completely.

If that doesn't put you off, however, and you want to tinker a little with your hardware, overclocking is a great way to have some technical fun with your PC. And let's face it, isn't that what we're all here for?

Beginning

In the past, overclocking a graphics card meant you had to know a lot about how the card worked, specifically how to tune the voltage and GPU core clock speeds. Luckily, the arrival of DirectX 11 (and subsequently DirectX 12) has put overclocking well within the grasp of most lay-users. You don't have to have a degree in electrical engineering to do it anymore.

The reason for this is that a pair of technologies – AMD's PowerTune and Nvidia's GPU Boot – mean that turning up the voltage and clock speeds together doesn't have the effect it used to. These days, it makes more sense to increase the voltage and let the card's own firmware and drivers worry about the clock speed. This prevents the GPU cores from artificially lowering their own clock speeds (throttling) because they're running beyond the manufacturer's stated power levels. The whole reason those limits exist is because the manufacturer wants to prevent the GPU temperature getting too high – but if you're using an aftermarket cooler, for example, it won't be a problem – unfortunately, the card doesn't necessarily know that.

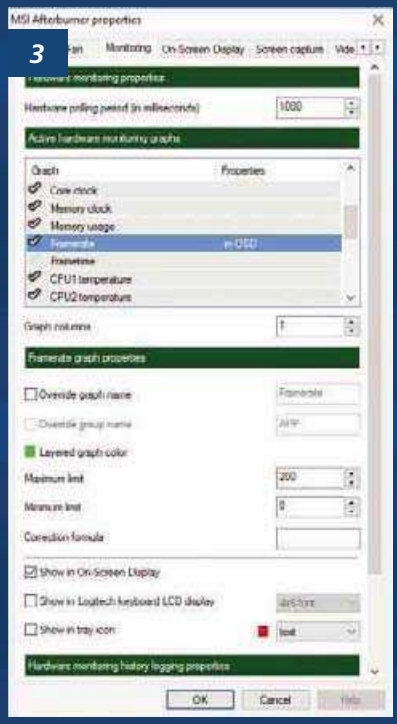
In any case, to start overclocking, you need to get the right software. Most CPU overclocks are done from within the BIOS, largely to prevent instability and data loss from within Windows, but GPUs can be edited and controlled without a reboot. Most card manufacturers offer their own tool, but because the software interacts with the GPU you aren't necessarily restricted to that tool.

To explain less abstractly, Sapphire's Trixx tool can be used on any AMD or Nvidia GPU Sapphire supports, even if the card itself was made by another manufacturer. The same is true of MSI's Afterburner tool and Asus's GPU Tweak. This means you can use any tool you feel comfortable with.

MSI's Afterburner is currently the most popular, so we'll refer directly to that. If you use another tool, though, you shouldn't have a huge amount of difficulty figuring out which settings are the equivalent.

Benchmarking

First, download and install Afterburner (**gaming.msi.com/features/afterburner**) and the RivaTuner Statistics Server it comes packaged with. The default skin is a bit much, so click the settings button (it's a cog icon) and find the 'User Interface' tab. We've



1. Afterburner's default skin; 2. Our preferred skin option; 3. Enabler On-screen Display; 4. Use the graphs to monitor your hardware's performance; 5. Increast core and memory clocks speeds gradually

"Most CPU overclocks are done from the BIOS, but GPUs can be edited and controlled without a reboot"

selected the Afterburner v3 Skin, but you can choose whatever you like.

Next, you need to enable two settings: in-game overlay and framerate monitoring. You'll find these in the 'monitoring' tab in the settings dialogue. Click the tick mark next to 'framerate' then below, tick the box next to 'Show in On-Screen Display'.

Now test your card's speeds to create a benchmark. You can load any game but we've chosen Minecraft. The frame-rate will appear overlaid in the top left of your game in purple numbers, allowing you to check the average speed. Make a note of this (you can also check the performance graphs) because this is the speed to beat. Also keep an eye on how the temperature and fan speed graphs look, because the closer to capacity they are, the greater the chance of your card being unable to take more overclocking.

If you want to be a little more scientific, you can use an actual benchmarking tool, but it's not required.

Overclocking

Now you know what you're trying to improve, it's time to actually improve it. Begin by increasing the power limit. You can move this all the way up – the artificial limit is there to prevent the card getting too hot, but it's usually a conservative estimate, and in any case there's a separate temperature limit.

Now you can use the Core Clock slider start actually increasing the GPU's speed. Do this in small increments of maybe 5-10MHz, clicking 'apply' and then testing your card with every change. If you experience no problems, do the same with the memory clock. Once you start getting graphical artifacts or unexplained crashes, take both of these settings down a little. That's the fastest speed for your overclocked card: just before you start seeing problems. Note that the Core Voltage will be taken care of by the card. Don't interfere with this unless you know what you're doing!

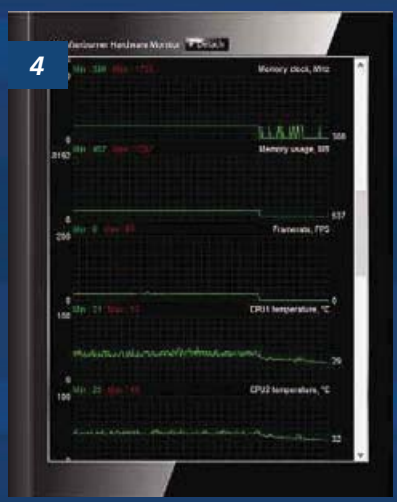
If you're not sure about the numbers, try googling your card and seeing what the average overclocked settings should be. Every individual card will be different, but you can at least get a ballpark figure! In MSI afterburner, you can save a profile, so you might want to save a specific overclocked setting so, If you ever want to put the card back to how the settings were, you can hit the 'reset' button.

Monitoring

Obviously, from this point on you have to be careful about your card's temperature to prevent damage, though be aware that any increase in temperature will shorten the lifespan of the card. Don't be too concerned – when's the last time a graphics card died on you, after all – but be aware that the faster and hotter it runs, the less time it'll run well.

If you are overclocking and don't have an aftermarket cooler, it's always worth looking into one. The card will naturally get less stable as it gets older anyway, and newer games will start to make greater demands on it. Just because it's fine with your current set of games, it doesn't mean it always will be – if you start seeing graphical glitches, quit your game and remove the overclock. It may not fix the problem (if the card is actually damaged) but at least it should prevent it from getting any worse.

Other than that, you're free to experiment and to enjoy the faster speeds on offer with your overclocked card! **mm**



IS eSATA DEAD AND BURIED?

Have new technologies supplanted the once high-end connectivity format?

It doesn't seem all that long ago since we first set our eyes on the opening wave of USB (Universal serial Bus) connectors. This technology was a huge step forward in computer connectivity, doing away with the bulky and often confusing serial and parallel connectors of the past and uniting devices with a simple, easy-to-use alternative.

USB quickly become the de facto standard in connections used in the PC industry and was enhanced with the faster USB 2.0 specification. Other technologies also surfaced on the market, most notably USB's biggest early competition FireWire. Despite a good effort, however, FireWire didn't have what it took to dominate the far more popular USB, which went from strength to strength, expanding out of the PC world and into other areas of technology and gadgetry. USB was on a roll and showed no signs of stopping. That didn't stop other technologies from trying, though.

Serial Atcha

Just as USB took over from the aging serial and parallel connectors for external devices, SATA (serial Advanced Technology

Attachment) represented the handing over of the technological baton from the older internal connection of IDE. Soon, SATA quickly became the standard internal connection for hard disks, and it brought with it faster data rates and general ease of use.

Like USB, SATA eventually improved, offering faster speeds with enhanced revisions, and it even broke out of the box with eSATA, the external format of the technology that allowed external devices like portable hard disks use the speedy SATA connection. For a while, eSATA represented the fastest and most useful connection for external drives, bettering USB. It became so successful that most motherboards started to include such connectors, and high-end PC users looked for this feature on any new purchase. For a while, at least, eSATA was the most desirable connection in terms of speed. USB wouldn't have that for long, though.

USBack

With eSATA offering far greater speeds than USB 2.0, offering a huge jump from USB 2.0's 480Mbps to a whopping 1.5Gbps initially, it was no surprise the new tech got a lot of attention, and eSATA improved further, widening the gap as it grew to 3Gbps and eventually to 6Gbps much later in 2008. It was the clear

choice for external storage and could even outperform most internal hard disks (aside from SSD).

Despite this difference in speed, USB was still a hugely popular format and still the most common found in the wild and used by hardware manufacturers. Not long after eSATA reached the heady heights of 6Gbps, a new USB revision arrived to even things out a little. In November 2008, USB 3.0 was released, which brought with it a huge leap in speed from USB 2.0. It offered a 5Gbps data rate, which was still one gigabit slower than eSATA, but

it included all the benefits of USB, which we'll come to later as we compare the two technologies in more detail.

USB 3.0 quickly dominated once more, and although eSATA was still very much a presence on the market and the optimal choice for power users, USB was the choice for most, thanks to it being easier and often cheaper to implement. Then, in 2013, USB arguably put the final nail in the coffin with its 3.1 revision.

USB 3.1 came with a major boost in speed, doubling that of the previous tech, taking the top speed up to 10Gbps, which overtook eSATA by quite some margin. This was enough to give USB the eventual win, and it has led to many PC users and critics proclaiming that USB 3.1 has effectively killed off eSATA, because the later technology is now all but pointless in the face of the far more powerful and cutting-edge USB.

More Than Speed

Looking at raw data rates is all well and good, and when it comes to connectivity, there's often nothing more important, but it's not the only consideration. There are other factors that come into play, and it's here where there's arguably even more of an impact for users that affects their choices.

These differences include any extra features or abilities a technology features, as well as any limitations that potentially get in the way. When we think of USB, for example, we think of its overall flexibility.

Thunderbolt

One of the lesser-known alternatives to USB, Thunderbolt is the out and out champion when it comes to raw data speed. Even the mighty USB 3.1 pales in comparison to the speed attainable by the latest iteration of Thunderbolt.

However, the odds are quite good that you've never seen this tech, especially if you're a PC user. Thunderbolt has been used mainly in Apple devices and is signified by a lightning bolt logo. The connector itself is similar to USB, albeit smaller, and it's known for ultra fast speeds, with the initial tech offering 10Gbps, the same speed the latest USB 3.1 offers.

Thunderbolt has evolved over time, though, and its second version upped this speed to 20Gbps and can power a 4K display. Thunderbolt 3, however, takes the real prize and can achieve speeds of 40Gbps. Intel has said Thunderbolt 3 can reach up to 50Gbps using silicon photonics tech and could even make 8K video possible. This isn't of much use right now, as there are no 8K displays, but it just goes to show the raw data handling power of Thunderbolt.

Despite this massive advantage of speed, experts fear that the future of Thunderbolt is rather shaky, as USB 3.1 is poised to dominate all the competition once more. This is understandable, as USB has become so synonymous with mainstream tech, and customers know where they stand. Any new connection type will have a hard time cracking this barrier, and if hardware manufacturers don't get behind the tech, it'll fail regardless of its technical superiority.

USB is, as the name suggests, universal, and it's designed to use the same connectors on all devices. In practice, this didn't turn out as well as hoped, with various forms of USB connector appearing on the market, but USB still prevailed. The competing eSATA had no

such problems, featuring the same connector, although it was only found in the PC world, so the format was limited and still is.

Cable length is a lesser-considered attribute, but when you're using plenty of external devices, it can be very important. USB cables can be longer than eSATA, giving USB an advantage, as users find it easier to manage their devices. USB cables are also often more flexible and easier to use.

Far more important, though, is USB's ability to supply power to devices via its own bus. Standard eSATA cannot do this, and it was only with the arrival of eSATAp that this was made possible. This powered eSATA variant could power compatible devices, but it was not backward compatible, and in doing so it sacrificed data speed by half, taking the maximum down from 6Gbps to 3Gbps. Oddly, USB devices could even use eSATAp ports, but the same couldn't be said the other way around.

A plus point for eSATA is the ability to use S.M.A.R.T. tech, as well as other low-level HDD functions that USB cannot. This gives the connection a definite boost in terms of storage and is perhaps one of the main reasons why it's still floating around and still a favourite of performance PC users who need good external storage.

FireWire

The first major competitor to USB, FireWire (also known as IEEE 1394) was initially one of the most powerful connection methods on the market and, like Thunderbolt, was popular with Apple. This was no surprise, because the company actually developed it. FireWire was also used in a range of high-end devices. It arrived on the market one year after the first USB (USB 0.8) in 1995. It was faster than USB at the time, and although the cable length was limited to around 4.5 meters, by using extenders and more cables users, could span longer distances if needed. It also offered power down the line, able to power external devices.

The first iteration of FireWire is known as FireWire 400, and it was further enhanced with additional versions, including 800 and 3200, with the latter being the most recent format offering data speeds of 3.1Gbps.

Like Thunderbolt, however, the overall appeal of FireWire remained rather small when compared to the massive success of USB, and although it gave USB a run for its money initially, with companies even releasing USB and FireWire versions of the same hardware, USB eventually won, leaving FireWire as a more Apple-focused format and one favoured by video editors.

Various reasons for USB's dominance are relevant here, with perhaps the most important being USB's relatively lower cost. USB devices required a USB bus in order to operate, such as ones found within a PC. This lack of built-in controller means USB hardware is cheaper. FireWire, on the other hand, is able to power itself, forming a kind of network between devices. FireWire can also transfer data without a host CPU and features two data buses. Until USB 3.0, this gave FireWire a clear advantage.

Sadly, FireWire was usually more expensive when compared to competing USB models and used different connectors with its various versions. Both facts surely contributed to the USB victory. People are always on the lookout for a money saver, after all.

Quick Comparison

Here's a simple comparison between the various connection formats and their revisions.

Format	*Data Rate (Mb/Gb per second)*	*Data Rate (MB/GB per second)*
USB 1.1	*12Mbps*	*1.5MB/s*
USB 2.0	*480Mbps*	*60MB/s*
USB 3.0	*5Gbps*	*640MB/s*
USB 3.1	*10Gbps*	*1.28GB/s*
FireWire 400	*400Mbps*	*50MB/s*
FireWire 800	*800Mbps*	*100MB/s*
FireWire 3200	*3.1Gbps*	*396.8MB/s*
eSATA	*6Gbps (1.5Gbps and 3Gbps in older revisions)*	*768MB/s*
Thunderbolt	*10Gbps × 2 (2 channels)*	*1.25GB/s × 2 (2 channels)*
Thunderbolt 2	*20Gbps*	*2.5GB/s*
Thunderbolt 3	*40Gbps*	*5GB/s*

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Overall Dominance

USB's eventual top speed and its variety of features that were perfectly suited to its uses were a recipe for success. Despite the missteps of various plug shapes and sizes, which caused confusion and inconvenience for some when they just needed a cable for a quick recharge, the format triumphed, and to this day it remains the most popular connection method for most devices, from PC hardware to mobile phones. Did it really 'kill' eSATA, though? Is eSATA actually dead?

USB has certainly hurt the overall appeal of eSATA, and while the less popular format had its uses for a while and arguably still does, there's no denying that USB has contributed to the decrease in the format's use. Hard disks were and still are the main areas where eSATA is the most useful, but now that USB 3.1 offers twice the speed with the added benefits of power, there's really no competition outside of Thunderbolt (see Thunderbolt boxout).

For the mainstream, USB has always been the connection of choice, and it has easily managed to weather the storm and come out on top. In all probability, eSATA in its current form will all but die out, used by some because they own compatible devices they don't want to part with or those looking for cheaper options, and until a new revision of eSATA surfaces, USB remains the king of connectivity.

Add to that the easy backwards compatibility of USB, as well as the simple fact that all PCs come with USB ports aplenty, but not all come with eSATA, and you've got the makings of another market takeover by USB. Like FireWire before it, eSATA may well be on the way out in mainstream use, and we'll have to wait for another potential contender to USB's throne. **mm**

Predecessors

It's a scary fact, but those of us not part of the new generation of PC users know that some technology we used to use is no longer even recognised by the younger generation. There's now a whole wave of younger PC users who have never used or maybe even heard of anything before USB. If this is you, you may find it useful to know about the older connection methods that were phased out by USB and SATA.

The main external connectors here were serial, parallel and PS/2 (not to be confused with the Sony games console), while internal SATA superseded the old staple that was IDE for hard disks.

Serial and parallel connectors were used primarily for external devices, as well as input like keyboards and mice. PS/2 eventually became the standard for input, though, and took quite some time to die off, with most users still having PS/2-to-USB converters in the back of their systems.

Serial ports, also called DE-9 ports, were nine-pin connections mainly used for input devices and other external hardware. Gamepads, modems, scanners, printers, mice and all sorts of other devices used this connector. The serial nature of the connection usually complied with the RS-232 standard.

PS/2 connectors were the primary method of plugging in a keyboard and mouse from the late 80s until the dominance of USB. Colour coded purple for keyboard and green for mouse, they were six-pin plugs that were named after the IBM Personal System/2 PCs.

Parallel was the main connection used for printers, until USB succeeded in unifying almost all devices under its encompassing umbrella. Is was a bulky, 25-pin plug, also called a DB-25 connector. Like most connections of the time, it wasn't hot pluggable. It was standardised in the late 90s, named IEEE 1284.

All of these ports and a range of other variants are now considered 'legacy ports', and users who need to use older hardware may need to know about these. PS/2 ports in particular can still be found on some devices and even motherboards. They're most often still found on KVM (keyboard video mouse) switch units, because they're known to be less troublesome when switching inputs between devices.

IDE (Integrated Drive Electronics) was the previous mainstay of internal hard disk connection, as well as other devices like optical drives. It was based on IBM's industry standard 16-bit bus. It was standardised by ANSI (American National Standards Institute) in 1990.

IDE used a 40-pin ribbon data cable for internal hard disks, as well as a smaller, 34-pin cable for floppy drives. These cables were cumbersome and were the bane of system designers who had to work around the flat, wide cables when planning system airflow. SATA and its smaller cables and faster performance eliminated all the downsides of IDE and performed far better.

All these connections have been replaced by either USB or SATA, and most new PCs don't even include them for legacy reasons, meaning special expansion boards are often needed if you plan to use older hardware.


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Micro Bit Coding

LED Fun

David Briddock explains how to control the Micro Bit's 5x5 LED display

Last time, we discussed the Micro Bit device and its coding languages, before exploring the Micro Python compatible Mu editor.

This week, we're going to get stuck into Micro Python code. In particular, we're going to explore what's possible with the Micro Bit's 5x5 LED display.

Before we start, make sure your Micro Bit is attached to your PC via a USB cable, then open the Mu editor app.

First Program

The first line in the programs we'll write is the same. It loads a Python library module that contains a collection of Micro-Bit-specific functions and classes. Depending on your version of Mu, it might start up with a new file that already contains the line we need. If not, click on the New icon to open a new source file and type the following:

```
from microbit import *
```

Now we're able to access any of those Micro-Bit-specific functions and classes. Let's begin by scrolling a text message across the LED display. On a new line type:

```
display.scroll('Micro Mart')
```

We'll need to compile, upload and run the program, but first make sure the Repl pane is open, because it helps with code debugging (see boxout).

Now, click the Flash icon. This will convert the Micro Python code into a binary 'hex' format file and upload it to the attached Micro Bit via the USB cable. As the 'hex' file is transferred, a message dialogue pops up telling you to wait for the yellow light to stop flashing. Once uploaded, the 'hex' file is executed by the ARM Cortex-M0 microprocessor.

Did you see 'Micro Mart' scrolling across the LED display? If you did, well done: you've written your first Micro Bit program. If you see some other message, there's a bug in the code, so check out the Repl pane for error information (see boxout).

Characters

Before we write more code, let's save the file. Click on the Save icon, then give it an appropriate name, such as 'led-fun.py'. Store it in a suitable folder or on your PC's desktop.

While the display isn't big enough to show words without scrolling, it works fine for single characters. To test this out is pretty simple. We just need to use the 'display.show()' function instead of the 'display.scroll()' one.

Back in the Mu editor window, type the following lines below the 'display.scroll' statement we entered earlier:

```
sleep(1000)
display.show('A')
sleep(1000)
display.show('?')
sleep(1000)
```

What we have here is a series of sleep commands, each one a second long, interspersed by 'display.show' function calls with a single character parameter. The sleep commands ensure there'll be a slight pause after the 'display.scroll' statement and between each 'display.show' statement, so we can see the LED display change.

Once again, click Save then the Flash icon to compile, upload and run the code. If you see an error message appear in the Repl panes, check your typing and edit the code to fix the problem.

Images

With a total of 25 individual LEDs, it's also possible to display little images. Even better, the Python library we've loaded already has over 60 predefined 5x5 pixel images. Let's try some out.

Repl Commands

We touched on Repl in the previous 'Getting Started' article. To recap, clicking the Repl icon opens up a pane below the source code, which contains an interactive Python command shell running on the Micro Bit itself.

To give it a try, click on the Repl icon. In the Repl pane, you should see a Micro Python version message followed by a '>>>' command prompt. Next to this prompt, type a valid Python statement. For example:

```
print(10*5)
```

If all is well, you'll see 50 appear in the Repl pane, followed by a new '>>>' command prompt.

```
from microbit import *

# messages
display.scroll('Micro Mart')
sleep(1000)
# characters
display.show("A")
sleep(1000)
display.show("Z")
sleep(1000)
display.show("?")
sleep(1000)
# images
display.show(Image.SQUARE)
sleep(1000)
display.show(Image.HEART)
sleep(1000)
display.show(Image.HOUSE)
sleep(1000)
display.show(Image.STICKFIGURE)
sleep(1000)
display.show(Image.BUTTERFLY)
sleep(1000)
display.show(Image.HAPPY)
sleep(1000)
# animations
display.show(Image.ALL_CLOCKS)
sleep(1000)
display.show(Image.ALL_ARROWS)
sleep(1000)
# DIY images
img = Image('90909:09090:00900:09090:90909')
display.show(img)
```

“With a total of 25 individual LEDs, it’s also possible to display little images”

First, click the Save icon to capture our most recent code changes. Then, below the existing code, type in these new code lines:

```
display.show(Image.SQUARE)
sleep(1000)
display.show(Image.HEART)
sleep(1000)
display.show(Image.STICKFIGURE)
sleep(1000)
display.show(Image.BUTTERFLY)
sleep(1000)
display.show(Image.HAPPY)
sleep(1000)
```

Once again, we have a series of ‘display.show’ and sleep command pairs. But this time, instead of text, we specify an image as the ‘show()’ call parameter.

Click the Save icon then the Flash icon to compile, upload and run the code. You should now see a scrolling text message, a series of characters and another series of images. Our program is coming along nicely.

Animations

The predefined image collection also contains two sets of images to represent clock time and compass directions. For example ‘Image.CLOCK12’ represents 12 o’clock, while the ‘Image.ARROW_N’ has a north-pointing arrow, with the full set being ‘N’, ‘NE’, ‘E’, ‘SE’, ‘S’, SW’, ‘W’, and ‘NW’.

However, in addition to the these image sets, there are two predefined image animation constants, which display the clock and direction images in sequence. Let’s try these animations.

First save the file to capture our recent changes. Then type in the new code lines below at the end of our program code:

```
display.show(Image.ALL_CLOCKS)
sleep(1000)
display.show(Image.ALL_ARROWS)
sleep(1000)
```

Click the Save icon then the Flash icon to compile, upload and run the code. After the scrolling text message, characters and images, you should now see a clock animation followed by a compass direction animation.

Individual LEDs

Static images are very useful in apps and games. Yet we can also programmatically switch on or off each individual LED. This means we can design our own images.

We can do this by defining a list of digits in five groups of five. A ‘0’ digit means off and a ‘9’ digit means full brightness. To create an egg-timer-like image, type in the following code at the end program listing:

```
img = Image('90909:09090:00900:09090:90909')
display.show(img)
```

Wrapping Up

Our program demonstrates how to display text phrases, characters and images on the Micro Bit. Feel free to edit the code and try different strings, characters and images.

Next time, we’ll look at buttons and sensors. Until then, have fun. **mm**

Code Debugging

If you upload a Micro Python program containing errors to the Micro Bit, it won’t run. Instead, you’ll see a scrolling error message on the LED display. However, it’s not easy to read this message.

To help debug your code, it’s a good idea to have the Repl pane open (use the Repl icon button). Now the full error message will appear in this pane. For example, it might say there’s a syntax error on line 12. Use this information to fix the code.

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WHAT HAPPENED TO WINDOWS GAMES?

Feeling nostalgic for Minesweeper or Solitaire after upgrading to Windows 10? **Sarah Dobbs** looks back at Windows games and where you can play them now

Thanks to the internet, it's now possible to waste hours upon hours while still looking, to the casual observer, like you're doing something useful at your computer. It wasn't always so; nope, back in the bad old days we had to rely on a handful of basic games to keep us occupied when we didn't have any work to be getting on with (or, you know, we did, but we felt like procrastinating instead).

Yup, once upon a time, families fought over who could get the best score on Minesweeper, and there was no thrill like seeing all the cards bounce around the screen when you'd managed to win a game of Solitaire. However, the games have disappeared from recent versions of Windows. There's no more clicking into the Accessories > Games folder to fire up Hearts in Windows 10. It's kind of sad... but, at the same time, most people probably didn't notice because, well, there's the internet now. What's more, computers tend to be more powerful and capable of playing games that are much more graphically intense than humble old FreeCell.

If you're missing those old classics, don't worry. We're about to take a long old wander down memory lane, looking back at where these games came from, where they went and where you can play them now if you really fancy it. Here goes....

Reversi

Windows 1.0 launched in 1985, and along with it came the first Windows game: *Reversi*. Based on the strategy game that dates back to the 1880s (or possibly even further back, since no-one seems to be entirely sure who originally invented it), *Reversi* pits the player against the computer in a thrilling game of… putting counters on a board. If you could place your counters so that they surrounded your opponent's, you'd get to claim them for yourself.

Can't remember it? It wasn't around for long. It was bundled with the first few versions of Windows, up to Windows 3.0, but after that it was replaced by *Minesweeper*, which is sort of similar strategically, if you squint. If you want to play it now, you'll find *Ultima Reversi* is free in the Windows Store. It's exactly the same game, just with far snazzier graphics – as you'd expect, given that more than 30 years have passed since the Windows 1.0 iteration of the game.

Ultimately, though, ***Reversi*** might've been the first game built into Windows, but it's not the most iconic. There have been far more memorable time-wasters…

Games in Google

Microsoft may have let us down on the games front ever since it launched Windows 8, but don't worry – Google's got us covered. Here are some of the games tucked away in its search:

Pac-Man

If you type "Google Pac-Man" into Google Search (or, you know, the address bar of Chrome), you'll see a special Pac-Man game appear. Specifically, it's a version of the game based on the Google logo and was actually the Google Doodle of the day on 21st May 2010. The truth is that everyone liked it so much it's been preserved, so you can face off against Inky, Blinky, Pinky and Clyde any time you feel the urge.

Atari Breakout

Type "Atari Breakout" into Google Images and you'll get a multi-coloured version of the classic paddle game. Use the arrow keys on your keyboard to move the paddle underneath the ball and bash away at those blocks until they're all gone. Note: *Pac-Man* and *Breakout* have sound, so if you're planning to play these at work, best to mute your computer or stick in some headphones.

'No Internet' T-Rex

Frustratingly, you'll only see this one when you've not got an internet connection but there's a T-rex platformer that's built into Chrome. Hit space and the T-rex will start running; when he's approaching an obstacle, you'll need to hit space again to get him to jump over them.

Minesweeper

Minesweeper might well stake a claim to being the most iconic of the Windows games. Developed by Microsoft itself and first available via in the Microsoft Entertainment Pack, it came bundled with Windows from 1992 and the launch of Windows 3.1.

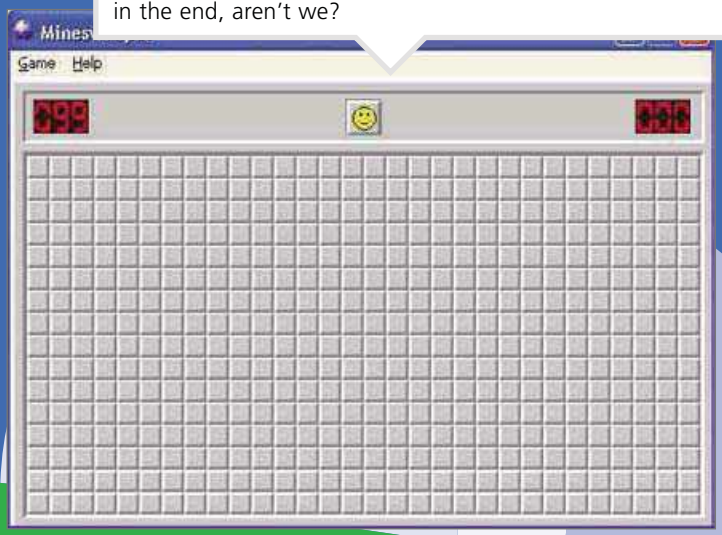
Conceptually simple, the game involved clearing a minefield by clicking on squares that don't have mines in them. To help you figure out which squares have mines and which are safe, spaces along the edges of cleared areas display a number, which tells you how many mines are in spaces adjacent to them. Right-clicking marks a space as a mine, while left-clicking clears it – left-click a mine and you're dead.

Part logic game, part mouse button tutorial, *Minesweeper* was dangerously addictive. You win by clearing the board, and the game also keeps track of your quickest time. Two minor elements contribute to its weird addictiveness: the timer, and the little smiley face in the middle of the screen that looks concerned when you click on a space and puts on its sunglasses when you win. It sounds ridiculous, but we're simple creatures in the end, aren't we?

Minesweeper changed slightly as Windows versions changed. The difficulty was tweaked over time; in the Vista version, the previously completely random grids made it so that the first square you clicked on would never be a mine. The game also got a couple of facelifts over time, with the Vista version letting players choose to play with flowers rather than landmines.

Still, the game remained largely the same until Windows 8, when Microsoft decided not to bundle *Minesweeper* into the operating system any more, instead offering a new version of the game free (but with ads) on the Windows Store. This version was developed by New York-based games makers Arkadium and looks completely different: instead of the iconic grey tiles, the new tiles are blue or white, and the smiley face is gone. Instead, there's an adventure mode, where you play as a questing hero making his way across treacherous terrain trying to collect treasures.

That's the version you'll find yourself playing if you want to do some quick clicking nowadays. It's still free but you'll need to fork out for a subscription if you don't want adverts. Sad times.



Solitaire

The other big hitter, Windows games-wise, is obviously *Solitaire*. Introduced in 1990, built into Windows 3.0, it's been around even longer than *Minesweeper* – and of course, the actual game of Solitaire is far, far older than that. Like Reversi, no-one's quite sure when it was first invented or who by, but Solitaire – known as Patience or Klondike when it's played in the real world with real cards – has been about since at least 1783.

In case you've somehow never played it, it involves shuffling a deck of cards and then laying them out in a series of columns, with most of the cards turned face down. Cards can be moved and placed on top of one another based on colour and suit, and the aim is to eventually sort the cards back into the four suits, in numerical order. (Again: it's easier to play than to explain.)

The Microsoft version of the game featured several card designs, including two different coloured fish cards, a rendering of a tropical island and a spooky bat-infested castle. Choosing a different card pattern didn't change the game, but it did make it feel a bit more luxe. When you were successful, unlike in the real game where you just get to shuffle the cards and start over, Microsoft rewarded players with an animation of the cards bouncing all over the screen.

Like *Minesweeper*, *Solitaire* was both a game and tool, designed to help users become accustomed to the drag-and-drop method of moving things on a computer screen, a process so intuitive that it's easy to forget we all had to learn to do it, but there you go.

Solitaire was a standard feature of Windows operating systems until, again, Windows 8, when it was relegated to the Windows Store. Which is still where you'll find it, again for free but with adverts built-in.

FreeCell And Spider Solitaire

Played too many rounds of *Solitaire* and starting to feel like you need to shake things up a bit? Microsoft had your back, with two different variations on the classic card game appearing in various incarnations of its Windows operating system over the years.

Microsoft FreeCell came first, appearing in 1995's Windows 95; *Spider Solitaire* arrived in Windows ME in 2000. They've been bundled together here for two reasons: one, because there's not that much to say about them individually and, two, because (you guessed it) they both got shuffled off to the Windows Store when Windows 8 came out. *FreeCell* and *Spider Solitaire* are now included in the *Microsoft Solitaire Collection*, which also includes the *Pyramid* and *TriPeaks* versions of the game. It's all the *Solitaire* variants you could ever want, basically.

Hearts

There's another card-based game that can't be forgotten here too and that's *Hearts*. A variant of Whist invented in 1750, *Hearts* is a game for four players that, when it appeared as part of Windows 3.1 in 1992, was intended to show off the operating system's networking capabilities by letting players do battle across a network. You could also play it as a single player, though, with the other three hands being taken by the computer.

The aim of the game is to end up with as low a score as possible, by either playing penalty cards – the hearts and the queen of spades – in a series of tricks or passing them to other players.

Hearts was included with every iteration of Windows, albeit with some cosmetic changes, from 3.1 all the way up to Windows 7. From Windows 8 onwards, *Hearts* addicts would (once again) need to get their fix via the Store.

Hover

If you had Windows 95 on a CD-ROM, you probably played *Hover*. Intended to show off the new operating system's shiny new multimedia capabilities, it was far more ambitious than the games I've talked about so far and saw the player zoom around a series of maps in a hovercraft, collecting coloured flags.

The aim of the game is for the player, in the red hovercraft, to get all of their flags before the computer, in the blue hovercraft, got theirs. Other bits and pieces would be scattered around the map for players to collect and power up along the way.

It only came with Windows 95, but Microsoft has developed a new version that can be played in-browser, so if you fancy it, head to **hover.ie** for a ticket back to 1995.

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3D Pinball - Space Cadet

Unusually, this Windows game was published separately first – and not as part of a Windows add-on pack either. Released in 1995 as *Full Tilt! Pinball*, it was a surprisingly detailed pinball game that featured three different tables for players to play through, each with its own mythology and imagery.

The single table version of the game that ended up built into Windows feature the Space Cadet layout, in which players must complete various different missions (by hitting different parts of the game table) to earn points and work their way up from Cadet to Fleet Admiral. It first appeared in Windows ME and was also included in Windows XP.

When Windows Vista rolled around, though, it disappeared. Unhappy customers found out why when a Microsoft engineer, Raymond Chen, published a blog post about it – basically, when the code from Windows XP 32-bit was ported over, Chen discovered a bug in the game that would see the ball disappear through an invisible hole in the table. The bug meant the game was essentially unplayable, and with a whole operating system's worth of code to worry about, Microsoft's software guys decided it wasn't worth bothering to try to fix the game. Thus it was 'bye-bye, *3D Pinball*'!

Some enterprising types found workarounds, however – mostly involving copying the program files from a Windows XP PC onto a newer one – but we're far enough away from good old XP now that you'd probably need an emulator to get it to work these days. If you really miss this one, you're probably best off opting for *Pinball Star*, which is free to download from the Windows Store.

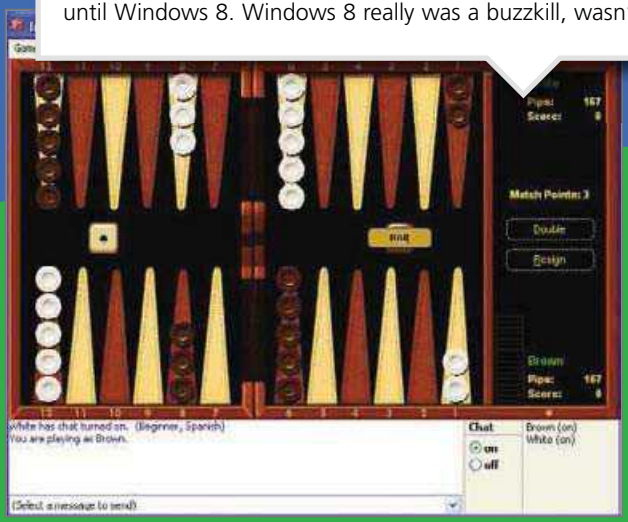
Internet Games

Windows ME introduced a whole stack of 'Internet' games – basically, games you could play with strangers online. Exciting stuff for 2000!

These games included *Internet Backgammon*, *Internet Checkers*, *Internet Hearts*, *Internet Reversi* and *Internet Spades*. None of them require much explanation, except maybe *Internet Spades* – a kind of variation on *Hearts*, that had similar gameplay but a different scoring system.

The point of these games was, again, to highlight new functionality. This time, the whole thing was about encouraging online interaction, by making it easy for Windows users to play games with strangers on the net. How times have changed.

Once again, these games were included in future versions of Windows, up until Windows 8. Windows 8 really was a buzzkill, wasn't it?



Purble Place

If you're reading this, chances are you're not in the right age bracket to feel nostalgic for *Purble Place*. It turned up in Windows Vista in 2005 and was aimed at young children – 6-year-olds and upwards. That in itself is sort of interesting and reflects some sort of change in how Microsoft saw their products being used.

The other games in this article are aimed at adults, probably adults looking to kill a bit of time on their lunch break or play games at home after work. *Purble Place* was aimed at young kids and yeah, by 2005, computers had definitely gone from tools we used at work to the centre of our everyday lives.

There's not a lot to *Purble Place*. Briefly, it's a suite of three mini-games: *Purble Pairs*, a memory game; *Comfy Cakes*, a coordination game; and *Purble Shop*, a codebreaker. They're all simple and kind of cute and easy. Purble Place was included with Windows Vista and Windows 7 and then all-business-all-the-time Windows 8 came along, and that was the end of that.

Chess Titans

Windows Vista also included *Chess Titans*, an almost photorealistic chess game that can either be played against the computer or against another human player. Chess games for the PC had been around forever, of course, but rarely if ever did they look this swish.

Like *Solitaire*, *Chess Titans* included different theme options, but its pieces definitely looked more impressive than even *Solitaire*'s bouncing cards. The 3D game board could be rotated, so players could consider their moves from all angles, and if you were playing against the computer, there were various different difficulty levels – plus a helpful mode that displayed all valid moves for any given piece, just in case you were missing something clever.

Other than that, you know, it was chess. Everyone knows what chess is and how to play it, and this was… chess. *Chess Titans* was built into Windows Vista and Windows 7, but oddly, there doesn't seem to be a version of it on the Windows Store. There are, however, plenty of other chess games available, should you be in the market for one.

Inkball

Another new game introduced in Windows Vista was *Inkball*. The basic idea is almost like Pinball, except here players have to guide balls into suitably coloured holes by drawing lines that the balls bounce off. Letting a ball go into a hole of the wrong colour ends the game, and there's also a time limit for completing each level. It sounds simple but, like Minesweeper, it's tougher and more compelling in practice.

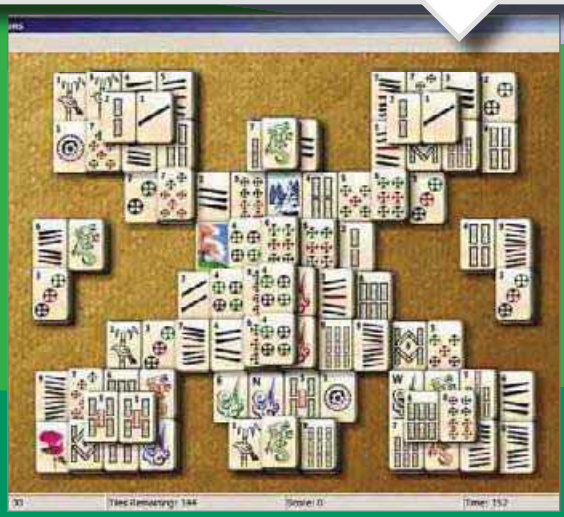
Inkball only appeared as part of Windows Vista and isn't even available in the Windows Store now. If you really want it and you've got an iPhone, you're in luck – it's available on iTunes for £2.29.

Mahjong Titans

The final game to talk about is yet another addition that was exclusive to generally disliked Windows Vista: *Mahjong Titans*. Like *Chess Titans*, it took an ancient game and made it look a bit swish, with 3D animated tiles. Once again, there were various style options available, plus a range of different tile layouts, to keep the game interesting.

Mahjong Titans is a pretty standard version of the tile-matching game: players must click on matching pairs of tiles to remove them from the board, but tiles can only be removed when they're on the end of a row, so it's down to the player to strategise and decide which pair to remove and when, to avoid being stuck with an unwinnable board.

As you're no doubt bored of reading, the game came with Windows Vista and Windows 7 and then was discontinued. However, you can get a free version of it in the Windows Store should you fancy a go.



What Is There In Windows 10 Then?

There have been a lot of surprisingly fun games bundled in with various iterations of Windows, and most of us probably have fond memories of spending time pitting our brains against them. However, as you'll have gathered, the most recent versions of Windows don't include any of them. Click on the Games option in Windows 10 and it'll look like there are some games, but they're not actually installed – click on them and they'll just take you to the Store.

Why did Microsoft decide to remove the games? Maybe because there weren't any new features we needed to learn through playing them. Maybe because some people had already started to complain about the space these unnecessary programs took up on their new computers. Maybe because *Minesweeper* couldn't compete with *Minecraft*.

Or, maybe, it was because someone somewhere realised that the people who wanted those games would go to the Store to download them – and may even end up handing money, directly or through ad revenue. Which is a very cynical way of looking at things, but it's probably the truth, sad as it seems.

Still, maybe a few ads aren't a huge price to pay for something as simple and fiendish as *Minesweeper*. In fact, I might have to go and download it right now…

The Time-Saving Apps That Want To Free Up Your Day

Rob Leane checks out apps that save time, not steal it...

Technology is meant to make our lives easier, but it doesn't always feel like it. Replying to messages across a zillion different platforms, searching endlessly for something you can only half remember, and getting lost in the procrastination-friendly wasteland of the web are all ways that having a phone in your pocket or a computer on your desk can actually make your life more complicated and crowded.

Our technology regularly becomes a sinkhole for time, making the modern age a difficult place to be productive and stay on schedule with work, personal projects, and anything else that you should be doing instead of faffing around online. A few brave apps are standing up to this status quo, however, by actually attempting to save you some time rather than stealing it away from you. With these guys on your side, you may be able to rescue some of the spare minutes that have seemed so elusive lately...

Todoist

Trying to keep on top of your workload is an easy way to waste time; many of us spend valuable minutes each day composing and editing detailed to-do lists. Over the course of weeks, months and years, this time adds up. We waste hours upon hours planning, when we could be doing instead, painstakingly plotting rather than ticking things off.

If that previous paragraph is ringing a few bells, it might be wise to download Todoist, which allows you to manage your tasks easily in a dynamic calendar format. You can add tasks in a second and tick them off when they're done. Or if it doesn't look like you'll manage to get something done today, you can just drag and drop it onto tomorrow's schedule instead. There really is no need to be writing new to-do lists every day when an app like this can do it for you.

Todoist

Full Contact

Trying to find someone's contact details is another common sinkhole of time; working out which of your email accounts they last messaged you on, tracking down that one message you need to refer to – it's easy to waste important minutes this way, especially if you've changed your contact details recently.

Enter Full Contact, the ideal app for contact management. Full Contact synchronises your address book across all the major communicative platforms and presents its findings in an easy-to-navigate list interface. The need to rummage through all your email accounts to find that one vital contact is completely nullified by this app.

If you add up all the minutes you've spent searching through your inbox for some contact details, across your whole

IF

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career, you'll be looking at a big pile of wasted time. That's time that could've been saved by using Full Contact.

IF by IFTTT

This is an app that could seriously save you some major amounts of time. In fact, it's very smart piece of software. IFTTT, for those uninitiated, stands for 'if this, then that.' It's a common term among spreadsheet lovers and coding aficionados, and it basically means setting up a function to automatically occur under certain circumstances. IF by IFTTT is a new app that brings this very handy process into the palm of your hand.

IF allows you to set up sets of commands that your phone can follow. For instance, 'If I post a picture on Instagram, then post it on Twitter as well' is cited as a common command on the app's website. Another is 'If I like a video on YouTube, then post it on by blog.' Even if you just use IF like this, to speed up your social media/blogging technique, it can undoubtedly save you significant amounts of time.

IF's functionality is wide reaching, though, and can do far more for you than that. It can access your phone's GPS, too, allowing you set commands like: 'If I'm in the local grocery story, then text my flatmates and ask if they need anything'. What's more, if you have smart tech in your home, it can link up to that, too (for example: if I leave the house, then turn down the Nest Thermostat).

Pocket

You're online at your desk, on a mission to look up something important and very much work-related. Then, however, you see something: an article that sounds super interesting, or maybe a link to video that a friend reckons you'll really love. You don't want to forget about this and miss out on the cultural nourishment. To hell with work – let's procrastinate.

That tiny decision – reading or watching something you shouldn't – is often the first step to wasting loads of time at work and subsequently failing to get something done. Pocket is the app that wants to help, by eliminating the age-old internet excuse of 'I don't want to forget about this, I'll never find the link again!'

Pocket allows you to save an article for later. So if you see something at work that you really don't want to forget about, you can 'put it in your Pocket' and read it on the commute home later, once the day's work is done.

LinkedIn Job Search

Not everyone has time to hunt for a job, no matter how much they'd like a new one. Finding those extra minutes a day to trawl through all the relevant websites in search of that elusive yet perfect opportunity is pretty tough when you have a job and/or a social life and/or a family. If you've been struggling with this recently, we'd recommend LinkedIn Job Search.

All you have to do is find ten minutes one day to download the app, fill in some details and conduct a few searches. From this information, LinkedIn Job Search will use its algorithms to work out the type of job that you're looking for. It'll then run searches on your behalf daily, and come back to you with a notification when it finds something for you.

LinkedIn Job Search also makes the application process easier, allowing you to throw your hat into the ring using the app rather than sending you to a third party website with a clunky, aggravating web form.

1 Password

We've all been there: when you just can't remember a password, and end up trying umpteen subtle variations on your usual one, wasting time and wearing down your patience. More often than not, this ends with you having to reset the damn thing, which takes up even more time. Even then, there's no guarantee you'll remember it next time.

1 Password is an app that aims to save you from such horrors. This is in app that dubs itself 'your digital vault.' It saves all your passwords and user names (and even your bank details, if you've had enough of typing those in time and time again), so you don't have to remember them. All you have to remember is your one unique password for the 1 Password app, and the app itself will do the rest.

A time saver, and a life-saver, this one – especially for those of us with lots of different accounts and weird passwords.

SwiftKey

When you're in a rush, and need to send a quick text, nothing is more infuriating than an autocorrect or a typo. That's especially true if you realise too late and have to type

a whole other message to clarify what you meant in the first one – meaning you've wasted twice as much time and effort than the original message should have taken.

If this happens to you all the time, you might think you have massive thumbs or poor coordination. Maybe that's true; still, it's no reason for texting to take up more of your time than it should. You shouldn't be punished for your huge digits and subpar hand-eye skills, but if you feel like you are at the moment, here's our advice: download SwiftKey.

This is a smart keyboard, which will integrate itself into your messenger apps and spot the common errors you make – and correct them. Once you've used SwiftKey for a while, your number of typos and wasted minutes will greatly reduce.

Snowball

Snowball (only available for Android, sadly for we iPhone users) looks terrific. It's an app that infiltrates your whole phone, links up with other apps, and controls what you see based on your preferences. If you're fed up of getting notifications about things you don't care about (Candy Crush invitations are lampooned in a promo video for Snowball), you just tell the app and it hides them from you.

"Using all of them might be overkill, and – ironically – probably cause you to waste time keeping an eye on them"

Snowball streamlines your notifications, then, saving you from the disappointment of picking up your phone after it dings to be met with something you didn't want to see. The app doesn't stop there, though: it also streamlines your messenger apps.

If you're fed up off flitting between texts, Facebook messages and WhatsApp chats, for example, Snowball can help you out. It'll put all your messages in one place, as well as save you from annoying and unwanted notifications.

Workflow

To even things out a little, this one's an Apple exclusive. A bit like IF by IFTTT, Workflow allows you to automate your phone. This is handy if there are certain tasks you do all regularly, spanning several different apps, which gobble up hours of your life over time. For example, you can set up a 'Workflow' the dictates 'when I take three pictures, convert them into a GIF and Tweet it'.

This makes Workflow good for people who have repetitive little tasks they always have to do on their phones, then. The app offers over 200 'actions', all functions of popular apps, which you can manage as you please by dragging and dropping them into a list. It'll save you time swapping between different apps, but could be deemed a bit niche.

Evernote

Evernote is ideal for those among us that are constantly picking up business cards, scribbling notes on bits of paper, or recording audio files of our musings so we don't forget ideas – it's essentially an app to help you organise everything that's on your mind, from work projects to personal flights of fancy.

The downside of being the sort of person who hordes information and cool stuff is the time it takes to find something again after you've squirrelled it away somewhere. Personally, I've lost lots of time looking

FollowUp.cc

Sleep Cycle

through messy drawers for that one idea I wrote on a post-it note last month.

With Evernote, you can make a note of anything, in any format. You can save a picture of a business card in there, with a note to explain to your future-self why you picked it up, for example. Evernote is a marvel for scatty people who are bursting with ideas but lacking a good place to organise them.

Focus Keeper

It's all too easy these days to lose a full day of what should be work to the perils of procrastination... Well, it is for me, at least. One funny YouTube video can lead to a Facebook chat, which can lead to reading an article, which can lead to more chat, more videos, more inane time-wasting... and nothing of worth achieved all day. If this happens to you a lot (or even a little) you might want to check out Focus Keeper: Work & Study Timer.

Focus Keeper is an app that looks to incentivise you to use time productively: if you can concentrate on getting some work done for 25 minutes, you can earn yourself a five-minute break for cat videos and chitchat. After four 25-minute sessions, you earn a longer break.

It's a simple app – essentially just a series of timers and bleeps – but an effective one, too. It's perfect for people who struggle with productivity, offering just enough free time to keep the spirits up while still prompting you to concentrate most of the time.

FollowUp.cc

Another niche one here, but nonetheless a big time saver if your job involves chasing people up using emails. FollowUp.cc is an app that could save you umpteen hours – and lots of effort – in the long run by essentially automating your workflow.

For example, when you start an important email exchange, you can get FollowUp.cc to schedule a follow-up message if you don't get a reply in your desired window of time. You'll never waste time chasing people up again, because the app will do it for you. It can also track when your emails have been opened, schedule emails to be sent at specific times, set reminders so you don't forget to contact someone when you said you would, and even 'snooze' low-priority emails when you're too busy to deal with them.

All these functions could save you time and effort, as well as helping you streamline your email usage. It's marketed pretty hard towards sales executives, but all sorts of people could make use of it, especially if their job revolves around email communications.

Sleep Cycle

Finally, here's an app that doesn't save you time in the traditional sense, but instead ensures that you start each day in a way that will stop you from wasting it yourself. Sleep Cycle is a smart alarm clock app that aims to wake you up at the best possible time, ensuring in the process a smooth start to the day and fewer minutes wasted in a grouchy, wrong-side-of-the-bed state.

Sleeping badly and waking up in a bad mood can really ruin a day, pushing productivity out of your mind and letting fatigue seep in instead. This is bound to cause wasted time through procrastination, which is not what you need on an important work day.

Sleep Cycle stops this from happening. It monitors your sleep using your iPhone's microphone, and determines the best time to wake you up – in time to get to work, of course – based on how deeply you're sleeping. You'll start the day in a better state, allowing you to make the most of the minutes and hours ahead.

In Conclusion

So, there you have it: a collection of apps designed to help you manage your days and save you time. Using all of them might be overkill, and – ironically – probably cause you to waste time keeping an eye on all of them. But we'd recommend picking out one or two that sound relevant to you, downloading them onto your phone and seeing how they can help you make the most of your time. **mm**

FIGHTING TECHNOLOGY WITH TECHNOLOGY

Annoyed by people using their phones in public? You're not alone. **Sarah Dobbs** looks what venues and companies are doing about it

We've all been there. Perhaps when you're settling down in your cinema seat ready to enjoy the film and the person in front of you pulls out their phone and starts texting, lighting up the whole room. Perhaps, you've been on a long train journey where the person sitting opposite has spent the whole time writing emails with their keypad sounds clicking irritatingly away. Perhaps when you've been at a concert where most of your view of your favourite band has been blocked by people holding their phones aloft, filming wobbly, grainy footage they'll never even watch back. Whatever the exact situation, it's virtually guaranteed that, at some point, you've wished you had some kind of remote control that could just turn everyone's phones off, just for a little while.

Well, you wouldn't be alone. You've probably been to places that ask people to turn off their phones: there are coffee shops with signs up encouraging customers to talk to one another instead of using their phones, quiet carriages on trains where people are meant to read or sit in quiet, phone-less contemplation, and there have even been instances of actors on stage pausing their performances to tell theatre-goers to stop using their phones during a play. None of this has really worked, though, and none of it is really enforceable (well, maybe the theatre one is, just because it'd be so intensely embarrassing to be the person singled out).

The battle against antisocial mobile phone usage is being waged, though. While asking politely hasn't worked, it now looks like some companies are bringing in the big guns – devices designed to ***stop*** people from using their mobile devices. Some of these devices are already in use; others are still at the patent stage, but might be coming to a pub or arena near you very soon. Will they lead to more social, considerate events? Or might they cause more problems than they solve? Well, it's not likely to be as simple as throwing a switch and getting everyone to behave perfectly, that's for sure. Let's take a closer look.

Shaming

One method that some London theatres are considering borrowing from China involves lasers. Nope, they don't make the offending phones disintegrate in their users' hands (though that would be kind of fun). Instead, they just shine a spotlight on the person who's texting in the theatre, as a way of shaming them into putting their phone away without having to stop the production.

The pros and cons of a system like this are pretty obvious. It might well work, because no one wants to be singled out as a rule-breaker in front of a whole theatre full of people, but it's also an additional distraction for the people around them. You might be able to ignore someone tapping furtively on their phone, but if there's a spotlight shining right on them, well, that's going to be even more annoying.

It's also the kind of thing that might work quite well in a theatre-like situation, where people are sitting still for long periods of time – and there are likely to be elaborate lighting rigs capable of picking out one specific location in the room already in situ – but in most other places, like trains, concerts, meetings, it's less likely to be a viable option.

So far, no London theatre has actually used such a system, though a couple of them have threatened to. The threat in itself might well be a useful deterrent, of course – it's entirely possible no venue needs to actually install any laser spotlights. They could just say they had and hope the idea scares people into keeping their phones in their pockets. You never know, maybe it'll work.

Stop The Signal

The next step up from, essentially, just telling people off is stopping them from using their phones by ensuring that they can't do anything useful with them. Like the spotlight solution, this is a fairly low-tech solution, by modern standards, but one bar in Hove has found a way to block mobile phones from receiving any kind of signal on their premises. How? By using a Faraday cage.

Can A Jammer Land You In The Slammer?

Reading all of this, you might wonder why any venue that's aggrieved doesn't just use a mobile phone jammer. While, in most cases that'd be a much simpler solution – and mobile phone jamming devices do seem to be readily available online, but there's a problem: they're illegal.

In the UK, the Wireless Telegraphy Act 2006 forbids the use of any device for the purpose of interfering with wireless telegraphy, which is a delightfully old-fashioned sounding term meaning you can't deliberately jam someone's mobile phone signal. It's an offence that could land you in jail for up to two years or you receive a fine. Though the Act doesn't specify a minimum or a limit, we'd bet on it being to be more than you'd want to pay.

It's not even legal to sell jammers in the UK, and anyone caught supplying them can be slapped with a fine of up to £5,000, plus the courts can seize their stock. As much as you might wish you could stop someone from talking way too loudly on the train in the mornings, it's really not worth the risk of tracking down a jammer. You'll just have to settle for glaring at them.

"Blocking specific activities is trickier and requires rather more involved solutions"

Invented by Michael Faraday in 1836, Faraday cages are essentially metal shields that interfere with electronic waves. The Gin Tub in Hove has been turned into a bar-sized one, basically – the owners installed tin foil and copper mesh in the walls, which makes it difficult (though not completely impossible) for mobile phones to connect to any network inside the building.

The cage doesn't do any damage to customers' phones, and all they need to do to get them working again is to step outside, where their phones should again pick up a signal. Certain areas of the bar also still pick up a weak signal, so depending on where people sit, they might still be able to send a cheeky text or three. But it's almost a complete black spot for mobile phone signal.

Like the theatre lighting idea, it seems likely there's a behavioural component to the bar's plan. The bar's website advertises itself as a place to "enjoy the lost art of conversation" and openly admits that patrons won't be able to use their phones. It's likely that people who go there already know they won't be able to use their phones and won't try; they're probably people who want the experience of going out with friends and not being constantly connected to the outside world. Mobile addicts, meanwhile, will go elsewhere.

It's clever but, again, it's not an approach that'll work everywhere. After all, the whole problem with mobile phones is that we can't quite seem to separate ourselves from them even when we know we should.

No Filming Allowed

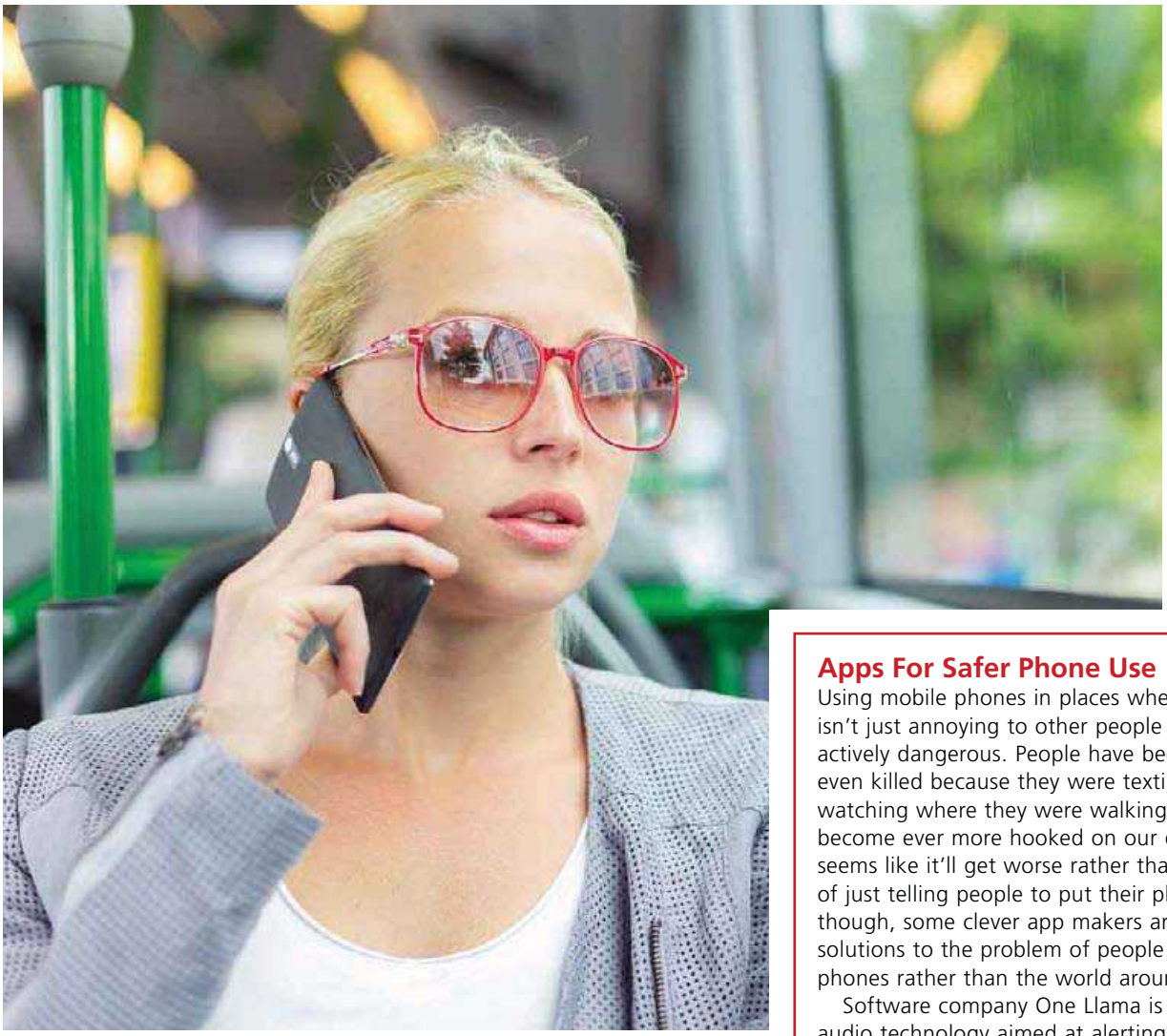
Both the shaming and blocking method attempt to stop people using their phones at all in a certain place or in a certain time, but that might not always be appropriate. Most of us like to feel that if necessary, people can get hold of us – if something happened to a loved one, for example, we could be contacted and told about it, no matter where we were or what we were doing. Those kinds of considerations might mean that total bans on mobile phones in places we go for entertainment and recreation are an inappropriate measure themselves.

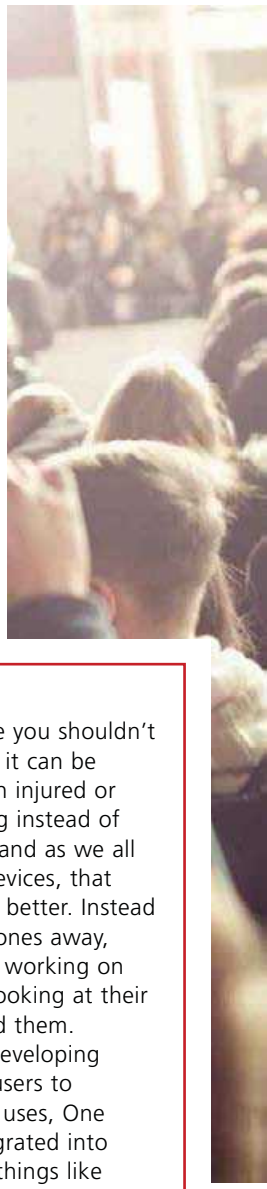
Blocking specific activities is trickier, though and requires rather more involved solutions. A patent filed by Apple suggests one way that venues might limit punters' mobile phone activities: the US 20150042819 patent, entitled 'Systems and methods for receiving infrared data with a camera designed to detect images based on visible light', outlines how using infrared devices might disable mobile phone cameras. As patents tend to be, it's long and full of legalese, but the bit that's relevant here says:

"In some embodiments, a device can, based on received infrared data, disable a function of the device. For example, an infrared emitter can be located in areas where picture or video capture is prohibited, and the emitter can generate infrared signals with encoded data that includes commands to disable the recording functions of devices."

The Apple patent application goes on to outline a couple of applications for this kind of tech, including concerts and cinemas. Once these kinds of devices are brought to market, a venue could install an infrared emitter next to its stage or screen, and then anyone trying to take a picture would find their phone incapable of photographing anything – but only the camera function would be affected, so punters could still use their phone to make calls and access the internet.

Whether this is likely to become a widespread phenomenon will depend on how well it works in practice and how expensive the system is to set up, but it does seem like some industries, particularly cinemas, might be interested to get set up with something that could





stop piracy in its tracks. The more paranoid among us, of course, might wonder what else such an emitter could tell our phones to do, if turning off cameras turns out to be so simple. Call us paranoid, but it's best to worry about such things before any device is actually out in the wild.

Lockup

Back to a method that is already being used, then – and this one is both super high-tech and also somewhat obviously low-tech. Various venues and performers, including musicians and comedians, have started issuing audience members with Yondr pouches before each show. The pouches, which are made of neoprene, are then locked so that people can't physically get their mobile phones out to film during the show.

That's the low-tech bit. These are basically just phone cases. The high-tech bit comes in with the locks. Once locked, the pouches stay locked until the phone's owner leaves the venue. Once they're outside of the zone set up by the venue, the lock springs open and the phone can be removed. So if there is an emergency, or you just decide you'd rather tweet than watch the end of a show you're not enjoying, you can just head for the door and everything's fine. Inside the venue, though, no one can film anything, take a call during the show or even snap a picture.

Again, you can see where that might be appealing. Musicians seem to have become increasingly frustrated with people filming gigs rather than enjoying them (perhaps as the quality of the recordings have also improved), with the likes of Rihanna and Adele yelling at fans to put down their mobiles. Comedians are even more incensed by the practice, because if all their

Apps For Safer Phone Use

Using mobile phones in places where you shouldn't isn't just annoying to other people – it can be actively dangerous. People have been injured or even killed because they were texting instead of watching where they were walking, and as we all become ever more hooked on our devices, that seems like it'll get worse rather than better. Instead of just telling people to put their phones away, though, some clever app makers are working on solutions to the problem of people looking at their phones rather than the world around them.

Software company One Llama is developing audio technology aimed at alerting users to dangers around them. Among other uses, One Llama reckons its tech could be integrated into phones so that users are warned of things like approaching cars – it can detect and alert users to sounds they might miss if they're wearing headphones (or are hard of hearing, of course).

Researchers at Rutgers University are working on similar warning systems; one app uses GPS to detect when a user is approaching a road and will freeze the phone's screen and flash up a warning to check before crossing, while another uses sensors built into shoes to detect if someone's stepped off the curb into the street while still using their phone and will issue a similar warning.

It's all clever stuff, but it does seem somewhat alarming that this is technology we need. More examples of stuff we probably shouldn't, but clearly do, need can be found in both the iOS and Google Play stores: the likes of Type N Walk and Type While Walk are apps that use your phone's camera to turn the screen 'transparent' (i.e. display an image of what's directly in front of you behind the message you're typing). If you've ever walked into a lamppost while typing, it might be worth installing one of those – you never know when it might come in handy.

“We’ll probably see more venues advertising themselves as phone-free”

best material can be seen and heard in half decent quality on YouTube it jeopardises their future ticket and DVD sales. With exactly this point in mind, lots of show footage is routinely removed by distribution companies for copyright infringement; however, if no one could even manage to film it in the first place, that’s obviously a win for the artists as well as the audience members – who might actually be able to see the show without a sea of screens in front of them blocking their line-of-sight.

While Yondr has been used by several acts now, it has some drawbacks; mostly, it’s expensive and a bit of a faff since the no-phone-zone has to be set up ahead of time, and then staff need to stop every single member of the audience and confiscate their phones from them (and probably explain exactly why they’re putting it in a neoprene pouch) before a punter can enter the venue.

If that venue happens to be the kind of place where ticket-holders expect staff to search their bags anyway, that might not make too much difference to the experience, making it’s just the cost that’s the problem. Yondr doesn’t advertise its prices, but issuing special pouches to thousands of people at a pop isn’t likely to be cheap.

Just Turn Them Off

In a world where people still use their phones despite being asked not to, a solution probably needs to be found. If Apple’s on the case, other handset manufacturers might also be interested in coming up their own systems, and there are certainly plenty of venues who’d like a simple way of getting people to behave themselves better when it comes to mobile use.

We’ll probably see more venues advertising themselves as phone-free in future, then, and the Yondr system also seems likely to be adopted more widely – in large venues, if not small ones. In the meantime, please be considerate of other people when you’re using your phone. It’d save everyone a lot of bother if we managed to turn our mobiles off ourselves sometimes. **mm**

Party Time For Christmas

Jump up for the festive season

PlayStation VR Goes On Tour

Try the next big thing for yourself

Sony has announced 'The Future of Play Tour', bringing the PlayStation VR in front of interested consumers all over the country.

Six locations will give gamers the opportunity to experience the "immersive world of PlayStation VR", with events running throughout October (Birmingham and Glasgow have already played host to the tour, so bad luck if they were close to you). Visitors to the series of events that will make up the tour, which is to celebrate the hardware's official launch on 13th October, will be able to get hands-on with a range of exclusive software titles. Among those titles are *Batman: Arkham VR*, *Eve Valkyrie*, *PlayStation VR Worlds* and the VR reboot of tank warfare classic *Battlezone*.

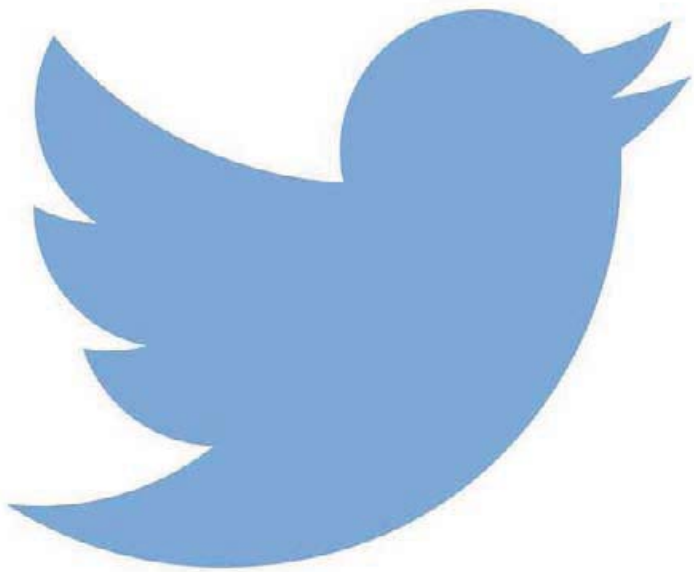
All VR software will be demoed on the PS4, and visitors will also get a look at the PlayStation Pro ahead of its own official launch due on 10th November. Read more on these events over at **www.trypsvr.com**.

Twitter Up For Sale?

Rumours abound

We've been here before but media reports have again suggested that Twitter has been in talks with a bunch of technology companies about a possible sale.

Among those interested in Twitter are, reportedly, Google parent Alphabet, Verizon and even Disney and it won't surprise you to read that a figure of $22bn has been mooted as being suggested for the value of the sale. Twitter, of course, is losing money right now but its strong and wide-reaching customer base provides an obvious reason as to why tech companies and beyond might retain a keen interest in the firm.



QUICK BITS... Google turned 18 on 27th September. For some reason, it decided that this was worthy of a Doodle

Christmas is often a good time to crack out a new party game for your console or PC, and this year Jamit Games is providing the game.

Coming to PlayStation 4, Xbox One and PC this December, *Jump Stars* is a multiplayer game that challenges gamers to simultaneous competitive and co-operative objectives, tasking players with meeting certain goals for the good of the party, while ensuring that players' own individual achievements will see them come top.

The game also comes with a bunch of 'unique' mini games to master, and key to the game's premise is that it comes with a somewhat unhinged virtual host introducing games that themselves are of the 'wackier' variety. As this is to cater for the whole family, we're not averse to this kind of approach, but doubtless it could irritate some older gamers.

Anyway, this is due out in December ,so if wacky party games is your thing, you can find a trailer at **www.jamitgames.co.uk**.

Yahoo Users Flee Over Password Hack

Not at all surprising

When it transpires that the personal details and passwords of over 500 million accounts have been stolen on your watch, it's not a huge shock when some of your previously loyal customers choose to jump ship.

Yahoo's gargantuan cyber breach from as far back as 2014 was reported by the world's press, and while those passwords affected were encrypted, it still hasn't exactly left users full of confidence in the company. As a result, many users closed their accounts shortly after the news got out, and experts have also warned that people would be wise to change their password, even if Yahoo hasn't been in touch to tell them to do so (anyone who has already altered their password after 2014 shouldn't have been affected by this, in theory).

The wider ramifications of this are massive, of course. For one, there are still plenty of users who adopt the same password across multiple online services, so they had to fix things there too, plus BT and Sky users were drawn into things, as their webmail services were outsourced to Yahoo.

Yahoo, quite rightly, is now under all sorts of scrutiny.

I've had my current PC for about five years now, and it's largely holding up okay, thanks to the addition of an SSD. However, the graphics card, an AMD HD 6950 (modded to run as a 6970) is in dire need of replacement. It still runs a fair few games at 1080p, but some newer titles barely run at all.

Luckily for me, I happen to have born in October, so I've put a brand new graphics card at the top of my birthday wish list, and I'm hoping Mrs Enticknap will oblige me with a fancy bit of silicon.

An Nvidia GTX 1080 would be lovely, but unfortunately, we haven't yet won the lottery (I've bought tickets, so I don't know what I'm doing wrong there). For that reason, I have my eye on an AMD RX 480, a fantastic card for people whose salary does hit six digits.

I also plan to stay with a 1080p monitor for a while, but not only because of the cost of a new monitor. I also don't really need to upgrade this right now. And if I did, I'd be needing a new graphics card again, much sooner than I planned.

By doing these things, I hope to get perhaps another five years out of this PC, with maybe a RAM upgrade and a bigger SSD along the way. For me, it's this kind of flexibility that makes PCs so great.

Anthony

Meanwhile... On The Internet...

As the role the internet plays in our daily lives has grown ever-larger, the importance of the content it carries, and the ways in which it does it have grown too. In a manner befitting its name, the web has pretty much everyone in the 'western' world trapped in its sticky clutches, to the point where the term 'tech news' often seems almost redundant. Perhaps 'life news' would be more appropriate because, if you can find the borderline where Team Meanwhile...'s digital and real lives begin and end, we'd appreciate it if you could pop over and point it out to us.

With this in mind, it's interesting to note some of the language surrounding cybercrime. For example, the semantic difference between the way the word 'leaked' was often used back in 2014 (**tinyurl.com/MMnet34a**) to describe the iCloud hack on various celebrities (**tinyurl.com/MMnet34b**) in a way that conflated the stealing of private photos from secure storage with standard paparazzo and tabloid story gathering techniques (let's not go into the ethics of that right now, though), and the outright use of the word 'stolen' that has come to replace it in the ensuing period of time as the media (**tinyurl.com/MMnet34c**) acclimatised to the fact that this sort of thing was not celebrity gossip and titillation, but something that we were all potentially vulnerable to (**tinyurl.com/MMnet34d**).

'Theft' and 'stolen' latter was certainly among the lexicon du jour when it came to describing the breach of Pippa Middleton's iCloud account in recent weeks, which saw something in the region of 3,000 photographs (**tinyurl.com/MMnet34e**) pilfered by a digital intruder into a very private part of her life (**tinyurl.com/MMnet34f**). Apparently, the hack came to light when *The Daily Mail* and *The Sun* were both approached via WhatsApp by somebody offering to share hand over copies of the images to them in exchange for £50,000. Whether that offer was made by the Nathan Wyatt, a 35-year old man arrested by police in Northampton (**tinyurl.com/MMnet34g**) for his alleged role in the hack, is unclear. That Miss Middleton later took legal action in the Queen's Bench division of the High Court action against 'A person or person's unknown' (**tinyurl.com/MMnet34h**) to prevent publication of the photos (**tinyurl.com/MMnet34i**) hints that there may be more people involved, and that not all media outlets have learned the lessons of the last few years and would still look to publish the images. Sigh.

In a similar manner to the way that technology has leaked into our everyday lives, criminality has slowly leaked in the opposite direction. While they may not physically fit the archetypal gangster stereotypes peddled in Hollywood gangster movies, there really is little difference to the approach and tactics (**tinyurl.com/MMnet34j**) of online criminals and the criminal elements (**tinyurl.com/MMnet34k**) we've come to accept as a sub-culture of the world (**tinyurl.com/MMnet34l**). Along with a largely amoral attitude to potential clients (**tinyurl.com/MMnet34m**), where money generally speaks a whole lot louder than anyone's conscience (though that works both ways, considering so-called 'legitimate' companies are offering off-the-peg hacking solutions to whoever will pay: **tinyurl.com/MMnet34n**), and a well penchant for trying intimidating those who would look to speak out against them, or potentially expose their nefarious activities.

Which brings us, rather unpleasantly, to the recent story of a DDoS attack (**tinyurl.com/MMnet34o**) against the site of cybersec expert Brian Krebs (**tinyurl.com/MMnet34p**) who, after running stories on a DDoS-for-hire service vDOS (**tinyurl.com/MMnet34q**) and reporting on the arrest of two men alleged to be owners of the operation (**tinyurl.com/MMnet34r**) was hit with one of the biggest DDoS attacks ever recorded, which at its peak was blasting his site with a almost unimaginable 600Gb/s-plus of data.

It was an attack that dwarfed the 300Gb/s one that sought to takedown the Spamhaus service in 2013 – and, we were told at the time, almost brought the web as a whole to its knees (though mitigation service Cloudfire's take on it – **tinyurl.com/MMnet34s**– is not accepted by everyone: **tinyurl.com/MMnet34t**). Apparently powered by vulnerabilities in IoT devices (**tinyurl.com/MMnet34u**) the attack was so virulent and long-lasting that net security firm Akamai, which had initially offered to help Krebs ward off the threat at no charge, had to backtrack on it's promise of assistance. That forced Krebs was forced to take the site down, until Google arrived in its Project Shield superhero costume to save the day. (**tinyurl.com/MMnet34v**).

That Google has initiated a scheme to offer cybersecurity and "free protection for news, journalist, human rights, and elections monitoring sites" indicates just how much the web has become the new frontier of bullying and intimidation 0 (**tinyurl.com/MMnet34w**) and how the "Democratization of Censorship" (in Krebs' words: **tinyurl.com/MMnet34x**) could be a major threat to free-speech going forward.

It would certainly seem that a thug is a thug, a thief a thief, or a bully a bully whether they whether they exist online or off-. As Woody Guthrie once sang: "some will rob you with a six-gun, and some with a fountain pen" (**tinyurl.com/MMnet34y**) and, these days, we could definitely add 'keyboard' to that lyric.

.AVWhy..?

Every now and then you come across a news story that at first seems intruiging but steadily becomes scarier the more you think about. This is one such story for us. For, while the news that Sony's research team has created an AI capable of analysing a whole heap of music and churning out a Beatles-esque pop melody based on the data (with a little help from composer Benoît Carré: **tinyurl.com/MMnet34z**) seems like a bit of fun, over time it begins to seem like it could be a warning of impending human obselesence.

QUICK BITS... Microsoft says that Windows 10 is now running on 400 million active devices

Caption Competition

We had a bumper bundle of funny for this fella, so let's get down to it, eh?

- **Thomas Turnbull:** "Well since they banned fox hunting, I've had to find another job."
- **Dwynnehugh:** "I did go to SpecSavers, but it didn't really help me."
- **BullStuff:** "The human would not take me walkies. I just ordered a truck load of Winalot and a ton of cement for the lawn. He who woofs last…"
- **doctoryorkie:** "I used to fetch the newspaper. Now I just email the headlines."
- **doctoryorkie:** "My byte is worse than my bark."
- **doctoryorkie:** "Incorrect spelling on the 'pause' key?
- **EdP:** "Its all pretty 'Pointless', everyone knows Richard Osman looks like me!"
- **David Paulson:** "Why the specs? Because he's a beagle-eyed reporter."
- **Dean Cooper:** "My dog loves internet dating. He just found himself a lovely new Lassie."
- **Robert Wheelhouse:** "They said I'd go blind and grow hairy palms. They weren't lying!"
- **Ian Marsh:** "Introducing the Dogshiba K9."
- **Lee Grimes:** "Obviously, he's from Berkshire."
- **Terry Wait:** "Fido hates you using his laptop, and he makes no bones about it."

The winner, though, is Leigh Spriggs with "He only uses wi-fi because he doesn't like CAT5." Well done, Leigh!

If you have a caption for picture below, head to the 'Other Stuff' section of our forum (**forum.micromart.co.uk**), or email us via **editorial@micromart.co.uk**, remembering to add the issue number to the email subject line.

Apple Buys Another Start-up

Another machine learning company

Apple has been busy snapping up tech companies once again, and it's another machine learning start-up: TupleJump.

TupleJump is, reportedly, an early adopter of big data and machine learning, and Apple has simply said that while it confirmed the deal has, indeed, been done, it doesn't discuss the details of deals like this.

Apple's interest in this Indian company is fairly obvious, given the importance companies are increasingly placing on AI.

US Student Hacks University System

Probably not his best idea

How not to succeed in education, number 341: hacking into your professor's computer to change your grades is a bad idea.

Chase Arthur Hughes, a student at Georgia's Kennesaw State University, was arrested and charged with hacking into the university's computers and stealing data, after it transpired that he changed a number of his grades. He didn't only change his grades either, helpfully altering the grades of some of his friends.

After Hughes' arrest, police investigators found the usernames and passwords for over 30 university faculty members written in a notebook in his home, giving police proof of his wrongdoings. Allegedly, one of the grades he altered was from an F to an A, so maybe that was the one that tripped him up. His crimes could lead to a 15-year prison sentence. Silly boy.

Snippets!

Samsung Delays Note 7 Sale

Following the very well-known and widespread issues surrounding the Galaxy Note 7 smartphone, Samsung has now said that it's delaying its planned restart of sales of the device.

The reason? It's the usual 'we need more time' excuse for the global recall. It's probably not such a huge surprise, given just how widespread and very serious this problem is, but as the adage goes, don't overpromise and underdeliver, chaps.

You Are Addicted To Your Phone

Yikes. According to a report from Deloitte, UK smartphone users are addicted to their devices, with a third of adults said to check their phones at night, many checking for messages or just checking the time.

The survey notes that the Fear Of Missing Out leaves some smartphone users addicted to their phones. Worry not, though, people: this a problem that will go away. The head of technology, media and telecommunications research at Deloitte was quoted by the BBC as saying that as smartphone technology is only nine years old, overuse of mobiles is but temporary.

Like iPlayer? Then Sign Up

Following the closure of the iPlayer loophole, the BBC has now announced that from early next year, all iPlayers users will have to log in with a personal account.

The BBC has said that it's also making current BBC ID holders add a postcode to their account information, and it claims that the changes are to help it to make its services "more personal and localised". Whether this will affect how many people use iPlayer going forward is anyone's guess.

Amazon Fined Over Dodgy Deliveries

Dangerous shipping lands firm with £65,000 fine

Amazon has been fined following a court case in which it was accused of trying to ship dangerous items by air.

The fine of £65,000 has been handed to the company after it was found to have attempted to ship lithium-ion batteries and flammable aerosols in flights in and outside the UK in four shipments between 2014 and 2015. Commenting on the fine, Amazon said, "The safety of the public, our customers, employees and partners is an absolute priority."

As for the flights themselves, the cargo was fortunately found when the Royal Mail screened the cargo before take-off and seized them before they reached the planes.

Snapchat Launches Sunglasses

Built-in camera to "create memories". Urgh

Messaging app firm Snapchat isn't just a messaging app firm any more. Now, it's launched its first gadget – a rather odd-sounding pair of sunglasses with a built-in camera.

The gadget, which adopts the frankly dull name Spectacles, will be available to buy later this year for around £100. The built-in camera will film in ten-second bursts, up to a maximum of 30 seconds of video, by tapping a button on the top-left of the lenses, and footage can be transferred by wi-fi or Bluetooth.

Importantly, a light comes on the glasses during recording time, which will assuage fears over being recorded in secret.

Snapchat has also undergone a brand name change itself and now called Snap, Inc. – most likely to represent this expansion of the firm's focus. Clearly we're been here before with Google Glass, and given that that particular device didn't last all that long, we're not sure this is really going to take off, but who knows. Go Pro on your face, anyone?

Gaming Display From ViewSonic

Features NVidia's G-Sync tech

ViewSonic's latest monitor is one for gamers, promising smoother images and various features to help players take it to the next level.

The 27" XG2703-GS gaming monitor features NVidia's G-Sync technology, which synchronises the frame rate output between the graphics card and the monitor, eliminating screen tearing and minimising stutter and input lag. The XG2703-GS has a 165Hz refresh rate, a 4ms response time and additionally features NVidia's Ultra-Low Motion Blur technology, which smooths movement and sharp edges, decreasing motion blur and minimising ghosting.

With WQHD (2560 x 1440) resolution, the display delivers sharp image quality, and stereo sound comes from dual integrated speakers. With a few features just for gamers too, such as Dark Boost adjusting the monitor's gamma curve to enrich the dark tones in a scene, and Flicker Free and Blue Light Filter technology built in for added extended viewing comfort, this specialist monitor will set you back £699. Read more at **www.viewsonic.com**.

Spectrum Vega+ Coming In October

It's really happening!

Six months after the initial Indiegogo-backed campaign launched, the Sinclair ZX Spectrum Vega+ is very nearly upon us. Launching on 20th October for anyone who backed it, the handheld Vega+, developed by Retro Computers (of which Sir Clive Sinclair himself is a shareholder and director), will come complete with 1,000 licensed games built into the device.

A launch event for the Vega+ is planned at SMS Electronics in Nottinghamshire, where we can only hope that people get dressed up as their favourite characters from a much-loved era. Horace in his skiing outfit, anyone?

Following the October launch, a wider retail launch is planned in time for Christmas "on selected online retail sites".

We've all been waiting for this for a while, so fingers crossed it turns out to be as good as hoped. You can still pledge to secure a classic black Vega+ via Indiegogo for £100.

Google Car Crash

This was a bad one

Another Google self-driving car has crashed, and this was particularly bad for the car involved, as it was well and truly bashed on the passenger side. Also, it's another accident caused not by the car itself but by that one problem that's hard to account for: the human factor.

The Lexus SUV was in a crash when another driver jumped a red light at a junction and drove right into Google's car. Airbags deployed and car towed away, Google's car was undriveable after that. Of course, Google's usual line of thinking when this kind of incident occurs is that we need more, not less self-driving vehicles on the roads to solve the human error factor. Google is still adamant that more self-driving cars means fewer accidents.

We'll leave it to you to decide what you think about autonomous vehicles.

Kobo Aura One

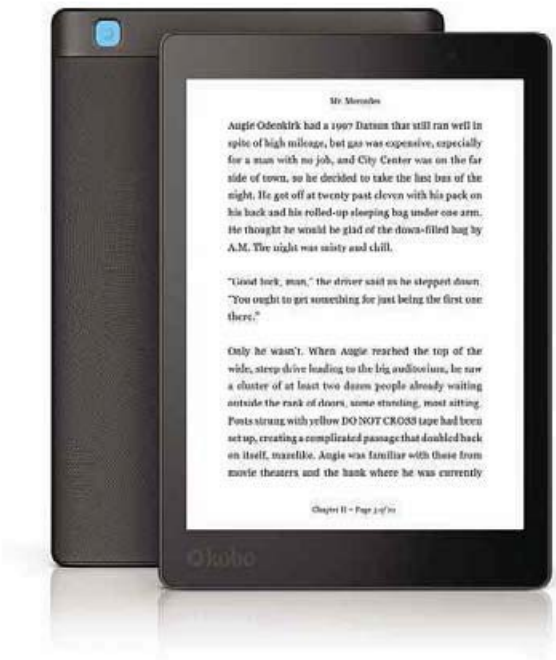
Better reading with this book-sized device

DETAILS
- **Price: £190**
- **Manufacturer: Kobo**
- **Website: goo.gl/NjnN9q**
- **Requirements: Most e-book formats, Kobo account for e-library reading**

The Kobo Aura One is the successor to the hugely popular Kobo Aura H2O that was released a few years ago. Since then, Kobo has seen a slight change to its line of eReaders, but the Aura still remains at the top of the range. Larger than the H20, the 7.8" screen with a Carta e-ink HD touchscreen and a maximum resolution of 1872 x 1404 of the Aura One puts it well into the realms of the tablet world, but also makes it one of the highest quality screens we've ever seen on an e-reader.

It measures 195 x 138.5 x 6.9mm and weighs a decent 230g. You get 802.11n wi-fi, but Kobo has gone one better again by including 8GB of storage built in. Although there's no SD card option with the Aura One, as there was with the Aura H2O.

The greatest selling point of the Aura H20 is obviously the screen, and thanks to the ClarityScreen+ technology and a 300dpi resolution, Kobo has created an e-reader that happily takes the pleasure of reading into new territory. Admittedly, you could argue that you can read a book quite as easily with an 800 x 600 screen as you could an 1872 x 1404 and, in most cases, you'd be correct. However, the detail and sharpness that the Aura One offers is exceptional and near-print quality.



The Kobo One is an impressive e-reader

It's big, but lightweight and has a great set of specifications

The Aura HD took an age to boot, and it felt very sluggish when you had to navigate the menu system. Kobo rectified that with the H2O, speeding up the process somewhat, and now the company has decreased the startup times once more with the Aura One. It's an extremely quick e-reader, with you being able to start reading from just a few seconds after pressing the power button.

The welcome, or home screen, contains all the necessary information you would expect. Your current library, the Kobo store, a search function, what book you're reading and the last time you synced with your computer are all present in a reasonably uncluttered fashion.

Battery life is rated at an impressive one month, and once set up you can view the usual list of ePub, PDF, TXT, HTML, CBR and so on, as well the more popular photo formats.

It's a nice device to hold; it feels sturdy enough, and not too cheap. The backlight is effective, and the screen is readable in pitch black and full-on sunlight without any problems or glare that leaves you feeling like you're suffering from flash blindness. Additionally, the screen will auto-adjust its brightness depending on the surrounding light levels, this also includes reducing the blue light for bedtime reading.

Another feature we rather liked is that the Aura One can be submersed in two metres of water for up to an hour and still be functional – providing the mini-USB port is closed off. Handy for when you drop it while reading in the bathtub, if you're at the beach, or fancy reading a spot of Jacques Cousteau while scuba diving.

E-reading is a pleasure with the Kobo Aura One. It's a sleek, comfortable device that's well-designed and fits nicely in the hand. There's plenty to like about it, and while it costs £190 there's the potential for it storing over 6,000 books which, for the bibliophiles among you, is probably worth every penny.

mm David Hayward

A great e-reader, with plenty of features and screen

Overclockers Techlabs Chameleon Watercooled Gaming PC

Despite the name, this extreme PC doesn't need to blend into the background

DETAILS
- **Price: £2,662**
- **Manufacturer: Overclockers UK Techlabs**
- **Website: https://goo.gl/hE1osa**
- **Requirements: Monitor, keyboard and mouse etc.**

Every so often the OcUK Techlabs team are unshackled and let loose on the workbench to create a monster of a PC. These prestige machines are often pretty extreme builds, using the latest and best components on offer, and costing a king's ransom. They are also extraordinarily impressive.

We were lucky enough to get our hands on one such PC, specifically the Chameleon Watercooled Gaming PC. It's an absolute beast of a computer that arrived at our door on a pallet and required a few strong backs to safely lug up the stairs.

Within the enormous Phanteks Enthoo Primo chassis, which measures 250 x 650 x 600mm, you'll find an Intel Core i7-6700K clocked at 4.6GHz fitted to an Asus Sabretooth Z170 S motherboard, with 16GB of TeamGroup Dark Pro DDR4 3000MHz memory, a 256GB Samsung 950 Pro M.2 PCI-e SSD with Windows 10 64-bit Home pre-installed, and a further Seagate 1TB hard drive.

Graphics come courtesy of an Asus Strix GTX-1080 Gaming, with a GPU clock of 1607MHz, a boost clock speed of 1733MHz, and 8GB of GDDR5X memory – clocked at 1251MHz.

While already quite an amazing setup, the Chameleon further impresses with the addition of an extreme watercooling system. The system uses a pair of EK CoolStream XE 360 radiators, one double fan placed at the bottom of the case and one three-fan radiator at the top. There's an EK X3 250 reservoir, complete with acrylic tubing and nickel fittings, filled with a white coolant to match the white PCB of the motherboard, internal fans, internal chassis, and internal LED colouring. It's a formidable setup, with not only the CPU being cooled in the system but also the graphics card (with a GPU cooling plate in place).

It's big, it's expensive and it's an outstanding design

The OcUK Techlabs Chameleon's watercooling is a thing of beauty

These components make the Chameleon one of the most capable gaming PCs we've tested in quite a while. The 3DMark 11 overall score, for example, was 22,979 – several thousand more than the winner of our recent VR gaming PC group test. The Samsung M.2 SSD performs equally well too, with a 4KB ATTO read speed of 569MB/s and write speed of 515MB/s. The 8192KB test saw a read speed of 2,187MB/s, while the write speed wasn't slow either at 945MB/s.

4K gaming was as near perfect as you can imagine with the Chameleon, with 85fps on *Doom* at 3840 x 2160, and 45fps from *The Witcher 3* – both with maximum or ultra settings applied. Other duties such as video and photo editing, and all media related playback at ultra-high resolutions, were handled without any issue.

The look of the system is also magnificent. Its white internal colouring, along with the white coolant and strip LEDs, against the black colouring of the chassis is quite a sight to behold – especially in a PC of this size. It is also superbly designed, with the watercooling pipework neatly routed through the rear channels of the case via rubberised grommets. Add to this the classy cable management and it's pretty close to a perfect setup.

As you would expect, the Chameleon isn't for everyone as it does come at a hefty price, £2,661.83 to be exact. Now that may be well and truly out of the range of most people's pockets, but for those who can splash out the Overclockers Techlabs Chameleon is one of the best PCs they could ever hope for.

mm David Hayward

Extraordinarily expensive, but an incredible PC

Toshiba Portege Z30-C-125

Toshiba lures business users with a decidedly utilitarian Ultrabook

DETAILS
- **Price: £1199 + VAT**
- **Manufacturer: Toshiba**
- **Website: www.toshiba.co.uk/laptops**

Looking at the headline cost, the kneejerk reaction is to wonder who might have the spare cash to blow on what seems to be a well-made but unexceptional Ultrabook. The Toshiba Portégé Z30-C-125 isn't made for a typical PC punter, though, it's built for business – where that cost level is justifiable, if not entirely expected.

The review Z30 came with Windows 7 pre-installed, exactly like the average business would like, because many skipped Windows 8.x and would like to put off the move to Windows 10 indefinitely. As hardware specs go, there is plenty of power under the plastic 'Cosmo Sliver' (read: gunmetal) exterior. It's built around a dual-core Core-i7 6500U at 2.5GHz boosting to 3.1GHz, it comes with 8GB of RAM and a 256GB Samsung PM871 MZNLN256HCHP solid state drive. That's a SATA M.2 SSD sadly, not the NVMe variety, but it's still more than quick enough for most users.

To that, Toshiba has added non-touch 1080p 13.3" panel, a membrane keyboard, large trackpad and a battery capable of powering this beast for 11 hours if you don't run games on it. With that spec, the Portégé Z30-C-125 has 'practicality' written through it like 'Blackpool' through a stick of rock.

What I still find difficult to accept, even though I weighed it, is that this relatively powerful system tips the scales at just 1.2kg, making it an ideal train journey companion. However, getting all that technology into such a svelte case was always going to be an engineering challenge, and achieving it has led to the odd sacrifice along the way.

The keyboard has a really nice action but its 87 keys are somewhat horizontally compressed, making it tough to use for those with the shovel-sized hands possessed by this reviewer. The best aspect of it is that it has a backlight. A feature I generally associate with gaming systems, though I can see how one might be useful on a long haul flight, for example.

Features
- Windows 7 Professional (available through downgrade rights from Windows 10 Pro on DVD)
- 6th Generation Intel Core i7-6500U Processor
- 13.3" Toshiba Full HD TFT non-reflective High Brightness eDP™ display with LED backlighting and 16:9 aspect ratio
- 256GB Solid State Drive
- Steel grey metallic, magnesium chassis, matt black keyboard
- 8,192 (1x) MB, DDR3L RAM (1,600 MHz)
- Intel HD Graphics 520
- Maximum Battery Life : up to 11h (Mobile Mark 2014 running Win10)
- Weight : starting at 1.20 kg
- W x D x H : 316.0 x 227.0 x 13.9 (front) / 17.9 (rear) mm

Equally, the screen is very sharp and has good contrast, but only when you're directly in front of it due to the TN technology used. Poor viewing angles might seem a problem if you're trying to present using one, but I'm sure some paranoid business people might prefer that others can't easily see their screen.

Where this design really delivers is in the number of ports Toshiba blessed it with because, as Ultrabook's go, this has a fantastic selection of them. Along with HDMI and VGA out, the Z30 has a LAN port, SD Card reader, headphone jack and no less than three USB 3.0 ports.

> **Has 'practicality' written through it like 'Blackpool' through a stick of rock.**

For those wanting even more connectivity than that, the underside or the Z30 has a proprietary interface designed for Toshiba's Hi-Speed Port Replicator III. The inbuilt wi-fi is 802.11ac compliant, and you also get Bluetooth 4.0 LE for connecting wireless peripherals, phones, and headphones.

In terms of upgrading, this looks a pretty good prospect if you're determined to get inside. Both the SoDIMM DDR3L memory slots can be accessed, and two M.2 slots. Both, however, require you to take out the 13 screws that hold the back on, (including three hidden under the rubber feet).

Encouraged, you are not. However, as only one slot each is occupied in the default specification, you could expand memory to 16GB and the storage by at least another 500GB if you're prepared to open the machine up, and possibly invalidate the one year warranty.

The flipside of this decent hardware is the way that Toshiba has pre-loaded all manner of junk on to it that no decent IT manager would ever deploy to an end-user. Ever.

In doing this what it has actually done is made what should be a difficult decision about whether to do a fresh installation an absolute racing certainty. If I'd spent this sort of money on a machine, I wouldn't be happy if it turned up pre-loaded with bloatware that I've now got to spend my time to remove.

Less plastic would be preferable, but the Z30-C-125 is a lightweight powerhouse that is great for anyone who works away from the office.

mm Mark Pickavance

An effective business Ultrabook with ports a plenty

Armello: The Usurper's Hero Pack

Kevin Pocock welcomes Armello's new treats

DETAILS
- **Price: £7**
- **Website: store.steampowered.com**
- **Developer: League of Geeks**
- **Requirements: Dual-core 2.0 GHz CPU or better, 2GB RAM, DirectX 10 GPU with 512MB VRAM, Windows 7 or later**

In the little over 12 months since *Armello* has been available, I've played very little. That is, after the initial addiction I lost interest. It's a shame, especially given that *Armello* offers a genuinely enjoyable experience for desktop and mobile users. It also offers solid replay value, and is a fine example of gaming success on Kickstarter. Now *The Usurper's Hero*, its first DLC, is here, but has any of my initial interest in this turn-based race to unseat a corrupted king resurfaced with it? Yes... Though, I fear, fleetingly.

Seeking to re-engage lost players and revitalise *Armello*'s loyal subjects, *The Usurper's Hero* offers four new heroes: Ghor (Bear clan), Elyssia (Rabbit clan), Sargon (Rat clan) and Magna (wolf clan). These arrivals are intriguing enough that I was happy to jump in and re-visit League of Geek's creation. As before, there is plenty to enjoy: the deceptively simple yet varied gameplay; the joy of a cunning dash to victory (and frequent sense of loss at being outplayed); the excellently epitomised strategy of physical board games. Of course, there's also the attractive design and music.

Yes, I have enjoyed *Armello* again. The new heroes. Ghor's affinity with forest tiles, Elyssia's ability to reinforce settlements for extra defence in battle, Sargon's ability to see drawn cards, Magna's damage reflect ability in battles (and awesome name). Each of these adds a new subtle mechanic to an already infused stew of skills and stats, spells, tricks and weapons. That is to say the new arrivals are enough to turn my strategic cogs. It's a tough ask as well. These parts of my grey gaming matter are mostly occupied by *Battlefield* tactics and incomprehensible *Hearthstone* defeat streaks.

The thing I can already feel is putting me off *Armello* (again) – especially when comparing it to other online games – is the lack of 'progression' beyond the necklace and ring unlocks available for each clan. Certainly the variety I play, characters and even types of victory in *Armello* is enjoyable. Yet, once you win or lose you just start again. Any desire to achieve more must go unquenched. This might be an unfair criticism to cast at the game – after all, it is effectively an online manifestation of a board game, a genre where you play, win or lose, hopefully learn from past experiences, and then you maybe play again. Perhaps not immediately, but still, that is typically the 'progression' on offer.

Armello is fun to play, but offers little progression

Armello disappoints, though, because it hints at more. Specifically, with an option as yet unfulfilled: ranked games. With no word as to when or how these will be implemented, this menu item has been 'greyed out' since Armello's September 2015 release. It is, of course, easy to understand why it hasn't been available; a title born of Kickstarter doesn't have unlimited resources. Yet the 'promise' exists without fulfilment, and it's ultimately what I find diluting my excitement for the game.

Ultimately, even with the arrival of the *Usurper's* DLC, my interest was unlikely to be held because I'm a competitive sort. That isn't an indictment of the title. *Armello* is fun, and *The Usurpers Hero Pack* reinforces it. I find it a little pricey at £6.50, but only because my interest is set to fade as before.

mm Kevin Pocock

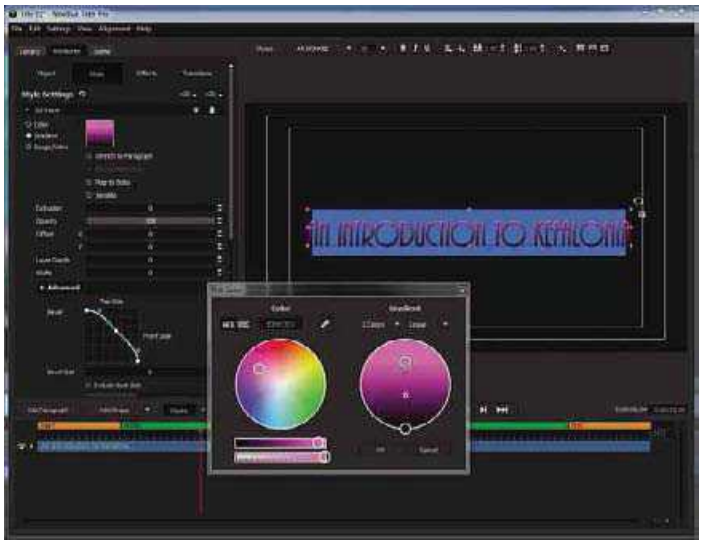
Usurpers refreshes Armello, but the base game needs more

Movie Edit Pro 2017 Premium

Produce more professional movies with Magix Movie Edit Pro 2017.

DETAILS
- **Price: £90**
- **Manufacturer: Magix**
- **Website: www.magix.com/uk**
- **Requirements: Dual core 2.4GHz processor, 4GB RAM, 2GB HDD, DVD drive for installation, GPU with resolution of 1280x768, Windows 7 or newer**

Lots of templates to get you started.



This shows the superb NewBlue titler in action.

The problem with reviewing video editors is that the one I'm reviewing at any given time tends to become my favourite. So, naturally, it's the one I use the most until a new one comes along, which is the case with this latest release of Movie Edit Pro 2017 from Magix, a company who undeniably produce more graphic and video-related products than any other. In fact, the previous version of MEP was still on my review machine, which is a testament to the impression it had on me.

Although it's true that most editing products provide a range of effects, transitions, and templates, Magix simply does it bigger and better. For example, after the product is installed and registered you're asked if you want to install the extras – a cache of assets that amounts to over 6.5 GB of data, in the form of design elements, DVD menus, slideshow styles, Vasco da Gama 9 Essential, NewBlue Title Pro, a soundtrack maker and 65 themed movie templates. You also get the option of saving all of these offline, in case you need to reinstall the software at some point in the future.

The MEP interface in this release is relatively unchanged, presenting the familiar timeline tracks along the bottom of the screen, underneath the preview monitor on the left and the media pool on the right. This is the default arrangement, but you have full control over the placement and size of each window to suit your projects. The premium version (reviewed here) provides 99 tracks to use for the ultimate in creativity, which is more than enough no matter how complex you make the production.

There are a number of new elements to this version, beginning with the introduction of 360° editing. Naturally you'll require a 360° camera to produce the footage in the first place, but I notice that these are slowly becoming a lot cheaper (in fact, at the time of writing, I see the Kodak PixPro 4K camera is now available for £339). Once the editing is complete, you can upload your productions directly to YouTube from within the program. There's a similar facility to upload videos to Vimeo in HD, but it doesn't currently support 360° footage.

Automatic Shot Match is another new feature designed to match the tonal and colour values between two different clips. The idea being to create a more natural transition between shots taken perhaps at different times of day, or similar locations; it's surprisingly easy to use and makes quite a difference to the flow between different scenes. You simply select the source and target frames and click the match shot button; there's also an intensity slider if you want to make any manual adjustments.

I think it's worth mentioning the other options you get with the premium version, such as the Vasco da Gama travel route plug-in. This allows you to create full 3D animated routes, graphically showing the itinerary of your trips utilising the extensive library of 3D objects and templates included. Although the main program has a rudimentary route option using a static map, the Vasco da Gama plug-in is much better.

There same can be said of the titling option, where the sophistication of the NewBlue titler plug-in significantly surpasses the one provided by Magix. While it includes a comprehensive range of templates, the power comes from the NewBlue title designer, with an almost unlimited range of options for creating everything from a simple lower third banner, to a full-blown animated 3D title that follows a pre-defined path across the video screen.

If you'd to try one of the Edit Pro products, there are free 30-day trial versions on the Magix website. **mm Joe Lavery**

Plenty of new features and content

Minix NEO Z83-4

Great things do indeed come in small packages

DETAILS
- **Price: £144**
- **Manufacturer: Minix**
- **Website: goo.gl/TmvwTu**
- **Requirements: Windows account, HDMI or mini DisplayPort monitor**

The Minix range of super-small PCs has recently seen an addition in the form of the NEO Z83-4. This remarkably minute, 127 x 127 x 27mm, PC is exactly what defines the company as a global leader in the small computer industry.

The NEO Z83-4 manages to pack in a decent punch considering its size. It has a 1.84GHz Intel Atom X5-Z8300 processor, 4GB of DDR3L memory and 32GB of eMMC 5.0 storage, on which you'll find a copy of Windows 10 Home 64-bit pre-installed.

Connectivity is good too, with 802.11ac dual-band wi-fi, Bluetooth 4.2, gigabit Ethernet, HDMI 1.4, mini DisplayPort, a single USB 3.0 and three USB 2.0 ports, SD card reader and a 3.5mm audio port.

As with the other Minix range, the NEO Z83-4 is a compact, sleek matte black PC that you can fit in the palm of your hand. Its tough plastic shell looks good and quite minimalistic, considering the number of ports that litter the sides; the Minix name is engraved on the top, for an added style.

The Minix NEO Z83-4 is a superb micro media PC

There's ample connectivity, and it performs well considering its size

In the box there's the machine itself, the power brick, a 1m HDMI cable and a blade-shaped antenna to screw into the available port to the rear of the NEO. You'll also get a product brochure and multi-lingual setup guide too, suffice to say it comes with everything you'll need from the off.

Although the specs aren't exactly gaming pedigree, the NEO Z83-4 does perform well. As a media PC, connected to a large screen TV, for example, it's superb. You can install your favourite media centre player and it'll happily play anything you can throw at it, including 4K content at 30FPS.

> **"It'll happily play anything you can throw at it, including 4K content at 30FPS"**

For normal day-to-day PC duties, the NEO Z83-4 works well. You'll feel a little cramped with an office suite installed, along with Windows 10, its updates and so on, but the 32GB eMMC storage is just enough to keep you going for a while. Of course, you could always look at the NEO Z83-4 as a business terminal-type machine that connects to a virtual machine image on the company server. There's more than enough processing power, memory and network bandwidth within the NEO to comfortably work as a hot-desk solution.

The fanless design of the NEO makes it an ideal quiet PC for media duties or as some kind of kiosk machine, for use in libraries and such. Again, thanks to the design, the NEO doesn't overheat or even feel too warm after a few hours' use – even after, we might add, pushing it with a two and half hour 4K movie.

Priced at £144, the NEO Z83-4 is another excellent micro-PC from Minix. It might not be up to playing the latest triple-A game on your 4K TV, but it's by far one of the best mini media PCs we've used.

mm David Hayward

Another excellent mini-PC from Minix

Varidesk ProPlus 36 (Black)

Standing up to the challenge of adjustable desks

DETAILS
- **Price: £335**
- **Manufacturer: Varidesk**
- **Requirements: A strong, flat surface**

If you've ever considered what it's like to stand while using your computer, you're not alone. As someone a few inches over six foot, I've often wondered whether I might be better off giving up on sitting altogether. This is where Varidesk comes in. The company produces a range of 'standing desks', of which the ProPlus 36 is one.

It's not actually a desk, though, it's a heavy duty, two-tiered, mechanical desk 'topper'. This 'topper' provides space for dual monitors, a mouse and keyboard, and can be adjusted for use at a range of heights.

'Heavy duty,' I said, and I'm not kidding. The ProPlus 36 weighs 32Kg, thanks to a solid metal support and hinge system. As such, safely shifting it probably isn't a one-person job. The weight of the item may be the only troublesome spec, though. The 36 requires a surface measuring a fairly standard 76cm x 61cm to perch on, and this should suit most desk or table spaces just as long as the surface is sturdy – again, this is a 35kg product and is itself capable of supporting an additional 15kg. Any table or work area it sits on clearly needs to be fairly strong!

The surface needs to be completely flat too. If, like me, your desk has a built-in monitor stand, then the ProPlus 36 won't suit (you don't want something this heavy as an over-hang!).

However, when in a suitable position the 36 is fine to work with. The monitor stand comfortably held my 23" monitor and 15" laptop, and the keyboard and mouse areas are comfortable for anything other than active gaming – more erratic mouse movements may exceed the space provided! It's also useful to note that the lower keyboard and mouse tier adds 2cm to the height of your desk when the 36 is fully collapsed; the monitor tier is 10cm higher.

How is working life standing up? As you'd hope, very good. It would be wrong of me to comment on any potential therapeutic benefits – although the chance to stand and stretch offered by the ProPlus 36 is a probably a positive. It's easy to do too: by standing, dispatching of your chair, and applying downward pressure to the sides of the monitor stand, you pull two hidden handles under either side. This releases the ProPlus 36's height mechanism, allowing you to control the up and forward swing of the 36 as the 'topper' separates from the metal base. The maximum lift of this 'stand-up' extension is 35.56cm, which should be enough for most to make positive use of. The 36 'clicks-in' at various heights when the handles are released, and at full extension even suited me!

One consideration is the length of cables attached to any items or peripherals as the height increases. Another, even more pressing, consideration is price. The ProPlus 36 costs £335. Yet, as a 'complete' mains-powered stand-up desk from a Swedish furnishing company costs around £100 more, this price seems almost sensible. A scratch-resistant finish, robust build, and sturdy engineering is part of the justification. The other is the ingenious mains-free height adjustment and two-tiered design.

That the Varidesk ProPlus 36 is available in black or white is a small bonus, but the main success is that this item exists at all. Heavy duty, fairly spacious, and with huge potential. I'm impressed – all 6ft-plus of me.

mm **Kevin Pocock**

An excellent adaptation offering good flexibility

GROUP TEST

PCI Sound cards

While the on-board audio is enough for most users, there are some who require something better.

Sound cards aren't as much a part of the average PC build as they once were, but there are still some superb cards waiting to fill your ears with glorious audio.

PCI Sound cards

Asus Xonar DS

DETAILS
- **Price: £35**
- **Manufacturer: Asus**
- **Website: goo.gl/1Vyvoa**
- **Requirements: Spare PCI slot**

▲ *The Asus Xonar DS is a good PCI sound card*

Asus isn't the first company that springs to mind when it comes to sound cards, but you'd be surprised at the variety of audio products it makes.

This is the Xonar DS 7.1, from the company's gaming and entertainment line of products. It's not quite at the bottom of the rung, hanging around as it does somewhere mid-range in the Xonar line-up. This makes it both interesting from the point of view of the audiophile, while still being relatively affordable.

The Xonar DS 7.1 is a thin, low-profile PCI card that uses the Asus AV66 audio processor, which in turn is an updated C-Media CMI-8788 OxygenHD processor. And the digital to analogue conversion (DAC) is handled exclusively by a Wolfson WM8776 for the front channels, whereas a Wolfson WM8766 handles the rear feeds.

In terms of the connectivity, there are five colour-coded 3.5mm ports on the back plate, placed in a row and easily accessible. They can be configured for 7.1 or 5.1 surround sound, and further tweaking of the channels can be performed within the Asus Xonar software.

While up and running, we noticed there was some significant distortion whenever Dolby Surround Sound was in use. It either didn't work at all or belted out a shrill, deafening noise until Dolby was disengaged and normal DTS stereo-to-surround kicked in.

> **"Generally speaking, the Asus Xonar DS delivers decent audio"**

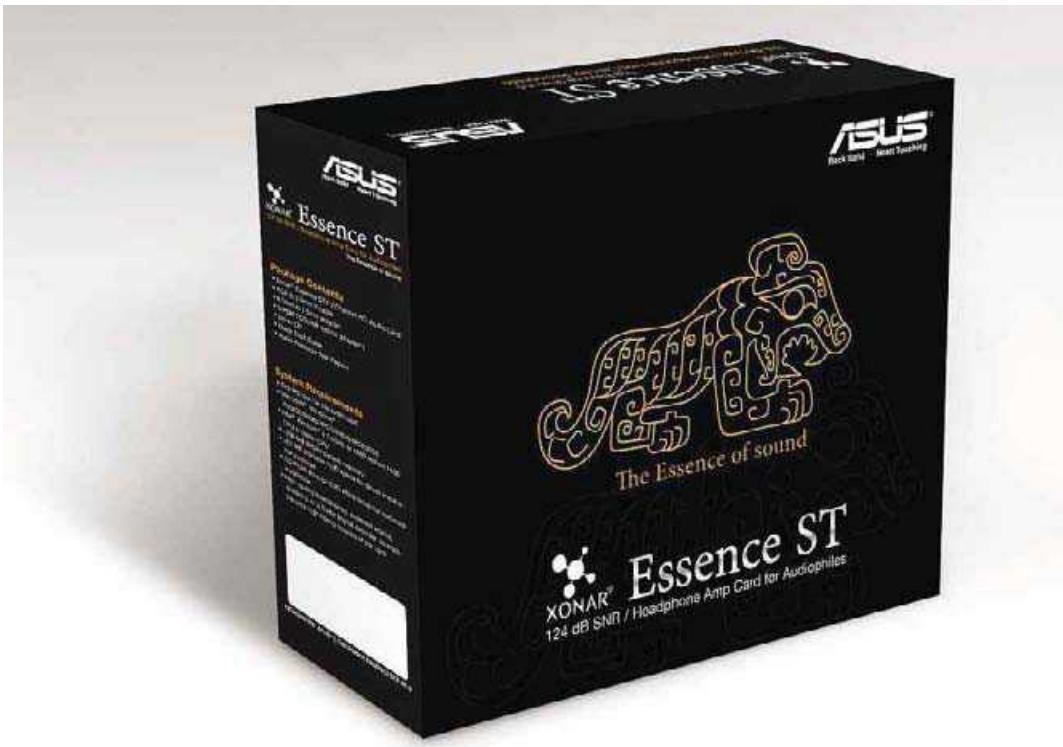
A little investigation discovered that although the processing is adequate for stereo to surround, Dolby Surround Sound isn't supported. This, of course, means that those looking for a true home theatre system will need to consider another sound card.

Generally speaking, though, the Asus Xonar DS delivers decent audio. It was certainly loud enough, and the quality was good enough for the average-sized living room media centre. The 5.1 setup we used was very good, in both gaming and films, and the S/PDIF optical out Toslink/combo worked well with the soundbar under the TV.

Overall, the Asus Xonar DS is a decent product. The sound quality is certainly good enough for most users and for most situations and home environments. But if you're serious about audio and you're trying to cover a larger area, then this probably isn't the card for you. Likewise, if you're using this for a more professional editing setting, then you'll need to find something with more power and features. If your needs are less demanding, though, it should be more than enough for you.

Asus Xonar Essence ST

DETAILS
- Price: £148
- Manufacturer: Asus
- Website: goo.gl/fYTcRL
- Requirements: Spare PCI slot



The Asus Xonar Essence ST is a great sound card

The second Asus sound card in the group, and it's a step up from the Xonar DS. The Asus Essence series of cards and other audio devices are geared towards high-quality sound production, using top-of-the-range components and features to deliver an incredible audio experience.

The Xonar Essence ST is certainly a suitably impressive sound card. It uses an Asus AV100 sound processor, which is actually the same C-Media OxygenHD audio processor used in AV66 from the Asus Xonar card. It also comes with a Texas Instruments PCM1792A for front output DAC and a Cirrus Logic CS5381 chip for 24-bit A/D conversion at sample 192KHz sample rates. Beyond that, there's also a Texas Instruments 6120A2 High Fidelity Headphone amp rated at 600 Ohms.

This all together creates a superb signal-to-noise ratio to reduce the amount of background interference and noise, as well as lowering the distortion of any output channel. The overall effect is very good, to say the least. There's also welcome support for Dolby Pro-Logic II, Digital Live, and virtual speaker and headphone technologies, along with a 3D virtual speaker shifter for custom positioning and support for the more common 3D sound engine APIs.

Along the backplate, you'll find five ports: two gold-plated RCA, left and right analogue inputs, then a pair of quarter-inch (0.25") stereo phone jacks for headphone, line and microphone and finally an RCA for S/PDIF output.

The card features a large shield over the analogue output processors, to cut down RF interference. This is a black anodised affair, which sports the Asus logo, as well as a gold emblem of what we think is a tiger, although it could also be a lion, cat, dog or some other four-legged creature.

The hardware, driver and software setup went perfectly fine on our test system. It's worth mentioning that the Xonar Audio Centre software was slightly different on the Essence as it was on the DS, and it allowed us a lot more control and tweaking of channels, sample rates and effects.

Once set up, the Xonar Essence was a superb sound card to use. Music, gaming and film were presented with a superb clarity, and thanks to a customised precision clock tuning engine, the quality of music was without a doubt one of the best we've ever heard.

> **"While the sound quality is excellent, the price isn't quite so much"**

Naturally, this level of audio bliss isn't going to be cheap. The technology involved is quite extreme, the sort of stuff that makes an audiophile get all foamy about the mouth. So while the sound quality is excellent, the price of £148 isn't quite so much.

Interestingly, the Essence ST is very near to being replaced by the STX, which appears to be a far more capable sound card. Sadly, we didn't have one available to test.

Creative Sound Blaster ZxR PCIe

DETAILS
- **Price: £160**
- **Manufacturer: Creative**
- **Website: goo.gl/Wa10jN**
- **Requirements: Spare PCI slot, spare backplate slot for daughterboard**

Yes it's expensive, but you're getting top-of-the-range audio technology here

Creative's sound card products don't really need any introduction. Since the early 90s, its products have been at the forefront of consumer PC audio.

The Sound Blaster ZxR is Creative's flagship, high-performance sound card, and it uses a Sound Core3D quad-core audio processor.

This is actually a sound card that comes in two parts. The main ZxR board features a pair of 0.25" stereo line and microphone ports, a pair of gold-plated RCA left and right ports and a further pair of 3.5mm jacks for 5.1 surround sound setups.

The daughterboard is powered by and connects to the main board via a ribbon cable. It doesn't need a spare PCIe slot, but you will need a free backplate slot to fit it into. On its backplate you'll find additional connectivity in the form of another pair of gold plated RCA ports, digital optical out and digital optical in. It's also worth noting that the daughterboard also has its own quad-core Sound Core3D processor.

In among that lot is a Texas Instruments Burr-Brown PCM1794 DAC to create an impressive 127dB signal to noise ratio, as well as an extra pair of Texas Instruments PCM1798s for digital-to-analogue conversion. The whole thing is connected seamlessly and produces some mightily impressive distortion-free sound reproduction, regardless of whether that's through a set of headphones or a full 5.1 surround sound set.

There is one final element to the sound Blaster ZxR, and that's an external audio control module that connects to the 0.25" microphone and headphone ports on the main card. This allows precise volume control, as well as conversion from the 0.25" connection to the more standardised 3.5mm jack.

The software is also pretty impressive, with crystal clear voice communications, Dolby Digital Live, THX Pro Studio technology and a rather splendid Scout Mode that boosts the mid-range frequencies for in-game location of enemies. That should be more than enough for professional audio technicians and enthusiasts to get stuck into.

Gaming was amazing with the ZxR, as was film and music audio. Everything was perfectly clear, and the clarity of each frequency was just magnificent and well beyond anything else we've looked at so far.

As we said at the start of the review, this is Creative's leading sound card, so it should be no surprise that it costs a pretty penny or two: £160, to be exact. As utterly amazing as the sound quality is, that's a little over the top for someone who plays *Battlefield* or *Call of Duty* every once in a while. Sure, it'll sound wonderful, but paying nearly £200 to listen to teenagers gun you down isn't something most normal folk are interesting in.

For professional PC audio users, though, the Sound Blaster ZxR is the card you should buy.

The Sound Blaster ZxR is an impressive card

micro mart
9 Quality
6 Value
8 Overall

Creative Sound Blaster Recon3D Fatal1ty Professional

DETAILS
- Price: £135
- Manufacturer: Creative
- Website: goo.gl/wx16gF
- Requirements: Spare PCI-e x1 slot

The Creative Sound Blaster Recon3D Fatal1ty looks good, but it's too expensive for what you get

Following on from the top-of-the-range Creative Sound Blaster, we have the Recon3D Fatal1ty Professional, a next-generation gaming card that's endorsed by Jonathan Wendel – or Fatal1ty, as he's known in the e-sports world.

This particular model is an upgrade from the last-gen Recon3D. There's not a huge amount of difference between the two, other than a new EMI protective shield over the card's PCB and components and some LEDs.

Connectivity comes in the form of five 3.5mm ports for 5.1 surround sound, full Dolby, a dedicated headphone port, and digital optical out and digital optical in. All this is handled by Creative's much advertised quad-core Core3D audio processor, which essentially accelerates and improves the audio and takes the weight of such tasks off your system CPU. The result, in this case, is a main CPU that is freed up to process gaming frame-rates or HD content, instead of dealing with the audio as well.

Beyond the hardware, Creative has put a lot of effort into making the most comprehensive suite of audio drivers and tools available. There's an improved voice processing driver for those using headsets: THX TruStudio Pro, which will enhance sound by adding virtual surround speakers, regardless of the current audio setup, and lend a deeper home theatre experience.

> **"There are many options to tweak the performance and enhance the audio"**

Naturally there are also many options to tweak the performance and enhance the audio. And we're glad to see that the software and accompanying drivers work seamlessly with Windows 10, despite the product being promoted as being for Windows 8.1.

The software features everything the Creative Sound Blaster ZxR has to offer, including the Crystal Clear Speech, Dolby Digital Live and the Scout Mode.

Sound quality from the Recon3D is very good, although it probably isn't quite as good as what the ZxR has to offer. In all honesty, there comes a point where the human ear (or ours, at least) isn't able to distinguish one high-end audio card from the next. Suffice to say, it's the sort of quality and clarity across all the frequency ranges that makes you realise just exactly what you're missing when you only use the motherboard's built-in audio options.

Gaming, film and TV were great, and the sound produced filled the room and made quite an impact on those watching and playing. There was easily enough power fed through these cards to fill a sizeable area, and if you're using a good-quality set of speakers or headphones, then you're in for a real treat.

It does cost somewhere in the region of £135, though, and if you're already paying that amount, you're better off saving another £30 and opting for the ZxR. However, if you can, try to pick up the original Recon3D minus the Fatal1ty endorsement, because they can be found for around £40.

StarTech 5.1 Channel PCI Surround Sound Card

DETAILS
- Price: £22
- Manufacturer: StarTech
- Website: goo.gl/qAu6PX
- Requirements: Spare PCI slot

The StarTech 5.1 Channel PCI sound card isn't great, but it's cheap

StarTech may often be regarded as the cheap, yet functional PC peripheral manufacturer, but most of its products do a pretty good job. At least, they fill the gap between the ultra-cheap and far too-expensive-to-warrant-buying market.

The company's 5.1 channel PCI sound card is one such example. It's certainly cheap, at around £18.99, and it's not quite on par with the other cards this week, in terms of design. But for what it's worth, it's a remarkable card.

This is an extremely slim, low-profile PCI sound card that offers five 3.5mm outputs for 5.1 channel 16-bit stereo. The audio is handled via a C-Media CMI8738-LX, which is towards the lower end of the audio processing range, but it does offer some rather interesting features.

For one, this is a great, cost-effective card for slim media centres, where the CPU may not be all that powerful and any processing removed from it will aid in the delivery of the content being displayed. There's a 32 Ohm headphone buffer, to help improve the kind of quality you would need when gaming and wearing headphones. And for any retro gaming enthusiasts, it's also legacy Sound Blaster Pro DOS compatible, but you may need to fiddle with the DOS drivers before it'll work correctly in DOSBox and the like.

The card and drivers worked perfectly fine under Windows 10, 8.1 and 7 (both 32- and 64-bit versions), and when hooked up to a decent stereo desktop speaker set or headphones it performed well.

We did find it gets quite hot, which could be a problem in tight spaces

Alas, you get what you pay for, and for just over £20, you can't really expect too much. Okay, this card works and produces sound, but the quality isn't great, and there we noticed a fair amount of distortion plus some missed notes and sounds when several instruments were playing at once. The balance isn't great either, and there's not much you can do when it comes to tweaking or calibrating the audio levels.

We also found out that the card gets exceedingly hot after about 30 minutes' use. It's not enough to melt any adjacent wires or anything, just enough to make you flinch if you touch it, but it does add a fair amount of heat to the system, and if you're using this in the tightly packed space of a small media centre case, then you could be in for some heating problem.

Despite this and the fact that the audio isn't great, even when used in a 5.1 setup, the quality is probably more than enough for most users' needs. It's certainly better than the built-in motherboard options that most of us use, and for £22 it'll happily work without any major problems.

Sweex 5.1 PCI Sound Card

DETAILS
- Price: £15
- Manufacturer: Sweex
- Website: goo.gl/0eB14n
- Requirements: Spare PCI slot

Sweex isn't exactly a well-known audio company, renowned for producing top-quality sound-related products. However, it does make a few internal and external sound cards, although the range is very limited.

This is the company's 5.1 PCI sound card, with a 16-bit 3D effect codec, full duplex playback and recording, five 3.5mm jack ports and a built-in microphone amplifier for when using headsets. All this is handled by the C-Media CMI8738-LX, the same audio processor as found in StarTech's 5.1 sound card. In fact, looking at the pair of them, it's quite difficult to tell them apart.

With the sound processor being more or less the same, the Sweex 5.1 PCI sound card isn't too dissimilar to the StarTech card, from a technical point of view.

There's the improved headphone buffer and the Sound Blaster Pro legacy support, plus it's extremely slim, just like the StarTech. There's a better 3D virtual surround sound setup feature, but no support for Dolby Surround Sound.

As before, this is an extremely cheap card (around £15), and its features and quality are limited by the cheap components used. This is another sound card that gets extremely hot when used for any significant length of time – an indication of the low-quality components used – and it's also one that fails quite regularly too.

▲ *The Sweex 5.1 PCI sound card is very similar to the StarTech model*

> **"The sound was pretty dire, especially when fed through a 5.1 speaker set"**

We used the card for about 15 minutes before it stopped working, and only a full power cycle would bring it back to life again. We did think for a moment that it was a problem with this particular card, but a quick check on various forums revealed that we aren't the only ones having this problem. There are even some who claim the card died altogether after just a month or two.

While it was working, though, the sound was pretty dire, especially when fed through a 5.1 speaker set. There was severe distortion when the volume was increased by just a small amount, and all the frequencies were dull, lifeless and very unclear. Voice in both film and gaming was horrendous and barley perceivable, which led us to increase the volume and create even more distortion, which made matters even worse.

We can confidently say, then, that this is by far the worst sound card of the group. When it worked, it was awful, and the fact it cuts out so frequently and after just a short time when active is really unacceptable in this day and age.

Rather than spend £15 on this card, we'd recommend you put it toward purchasing a half decent set of headphones and using the audio device on your motherboard. You'll certainly get a better experience, and you won't need to keep restarting your PC to get the sound working again.

Creative Sound Blaster ZxR PCIe

Although the Creative Sound Blaster ZxR PCIe costs £160 and is the most expensive card of the entire group, it does mark the pinnacle of sound card technology. It's quite an amazing product, and it's not just one card you're buying but rather three separate elements. If you're serious about audio, then this is the card for you.

Asus Xonar DS

If, on the other hand, you don't want to spend £160, the Asus Xonar DS is an ideal sound card, which will beat anything most motherboards have to offer.

It's got everything you'll need from a sound card, plus the quality is more than enough for most users'.

How We Tested

Each sound card was tested with an Asus Z170-A motherboard. The cards were connected to a 5.1 Creative speaker set, a pair of stereo desktop speakers and a set of Roccat Kave gaming headphones. We sampled various games, films and music for a wide range of instruments and voices.

	Asus Xonar DS	Asus Xonar Essence ST	Creative Sound Blaster ZxR	Creative Sound Blaster Recon3D Fatal1ty	StarTech 5.1 Channel PCI Sound card	Sweex 5.1 PCI
Price	£35	£148	£160	£135	£9.58	£10.57
PCI Type Used	PCI	PCI	PCIe x1, x4 or x16	PCIe x1, x4 or x16	PCI	PCI
SNR (Signal to Noise Ratio)	100dB	124dB	124dB	102dB	20dB	20dB
Sound Processor	Asus AV66	Asus AV100	Sound Score3D quad-core	Sound Core3D quad-core	C-Media CMI8738-LX	C-Media CMI8738-LX
Digital Optical?	Via combo port	No	Yes – via daughterboard	Yes	No	No
Low Profile?	Yes	No	No	No	Yes	Yes

Component Watch

Running out of storage space? If so, one of these big hard disks is the answer

Even though SSD prices are dropping rapidly, a cheap mechanical hard drive remains the best way to beef up your storage. Drives in the multi-terabyte range are supremely affordable right now, and that's why we've dedicated this week's column to finding the best high-capacity storage drives at the best prices around.

Deal 1: Seagate Barracuda 4TB (ST4000DM000)
RRP: £124.99 / Deal Price: £106.47

Seagate makes reliable drives at any price and capacity, so that should make this one worth a little attention, especially since you get access to Seagate's DiscWizard software, designed to make upgrading to a large drive that little bit easier. A 64MB cache and 5900rpm speed are both lower than Toshiba's model, though, so if you're looking for speed over reliability or ease of use, it may not be your first choice!

Where to get it: BT Shop – bit.ly/2cDYRZ9

Deal 2: Toshiba X300 4TB (HDWE140EZSTA)
RRP: £119.99 / Deal Price: £113.99

The Toshiba X300 4TB drive is a 3.5" SATA-3 drive, which combines low power draw with high-capacity storage. At £114, it's still quite cheap for a 4TB drive, but it has extra power and performance worth paying for over the cheapest drives, including a 7200rpm speed. A 128MB buffer and 11.3 watt active power consumption are both pretty good for all-purpose drives of this size, so if you like the price, there's nothing that should put you off here.

Where to get it: Ebuyer – bit.ly/2cDYkqt

Deal 3: Western Digital Green 5TB (WD50EZRX)
RRP: £189.99 / Deal Price: £169.99

Western Digital's Green drives are optimised for performance and power consumption over speed, which is why this 5TB drive makes for an attractive purchase – especially given the price. It's actually a little cheaper than the 6TB version (which we'll look at in a moment), so if you're interested in high capacity at low cost, the 5TB version is the one to look out for.

Where to get it: Laptops Direct – bit.ly/1ouqt9n

Deal 4: Western Digital Green 6TB (WD60EZRX)
RRP: £199.99 / Deal Price: £179.94

The 6TB version of Western Digital's drives are some of the highest capacity on the market, and while there are versions optimised for surveillance and NAS use, the Western Digital Green line is great for desktop users, with low power consumption and low noise levels but high speed access. And it comes with a two-year warranty, which suggests a reasonable level of confidence in the hardware!

Where to get it: Overclockers – bit.ly/2cDXl9y

Deal 5: Seagate Archive 8TB (ST8000AS0002)
RRP: £229.99 / Deal Price: £207.32

Cheaper, per gigabyte, than even some smaller hard drives, the Seagate Archive is the highest-capacity consumer drive on the market, and it's aimed at archival storage purposes (hence the name). It has a low 5900rpm speed, so it's not intended for use as a main hard drive, but it's definitely worth picking up if you're looking for a way to hoard all your data in one place – especially when the discount is this good!

Where to get it: Saverstore – bit.ly/2cNEagW

Podcast Round-up

James Hunt offers up a selection of scientific shows

Everywhere you look, you find people talking about storytelling. From the news to advertising to television, it's not enough to present the facts anymore: you also have to present a story.

In fairness to this view of the world, storytelling is the most basic (and probably the second oldest) form of entertainment, whether you're trying to make people laugh or cry – and these podcasts know that very well.

No topic, no agenda, just interesting stories from people you might never meet were it not for the internet.

The Moth

The Moth is a huge storytelling organisation, running 500 live shows a year with a presence in 25 cities. Recorded live, the content could be taken from any event from 20 years of The Moth's existence, meaning the breadth of the material is second to none.

Events don't have any specific theme beyond a prompt handed out to the audience, who are then given the chance to come and deliver their piece. The organisation's fifth UK show at this year's London Podcast Festival just sold out – as do most of its events.

It's this simplicity which makes The Moth compelling listening. Most of the storytellers are people you'll never meet and may be from an incredibly different walk of life to you. Their 'mainstage' events invite big, often unexpected names like Malcolm Gladwell, Suzanne Vega and Ethan Hawke. The sheer volume of material can sometimes seem intimidating – but two 15 minute stories a week means it's more than manageable. And hey, if you just want something to listen to while you fall asleep, you'll virtually never run out of material to wade through.

URL: themoth.org/story-library/podcast

Start With: *Liverpool Street*, a story from famed British author Neil Gaiman about waiting in Liverpool street station for parents who never show up.

Snap Judgment

If The Moth is about everyday people telling their everyday experience, Snap Judgment is about everyday people telling their unique, strange and incredibly unexpected stories. A CEO negotiating with pirates halfway across the world, a holocaust survivor's time in a concentration camp, a man whose nervous breakdown leads him to set up a utopian commune in a remote corner of Scotland – you never know where things will go.

Each episode of Snap Judgment is about an hour long and contains 3-5 stories, including one from the incredible engaging host Glyn Washington and others from guests selected by the production team. Stitched together by theme and interspersed with original, laid back music, it's relaxing and interesting in equal measure. New episodes are delivered every two weeks with older ones re-presented in the off weeks, so you can take it slow OR fast depending on how much material you feel able to keep up with.

URL: snapjudgment.org

Start With: *Caught Up*, three stories about people who aren't in control of their situation, including two guys who become accidental arms dealers and another about 24 people trapped inside a storage room during a hurricane.

Love + Radio

Part of the Radiotopia network, Love + Radio is labelmates with the likes of 99% Invisible and The Theory of Everything. Although it offers slightly more 'This American Life', documentary-type storytelling than the previous two podcasts on this list, the focus on emotional experiences sets it apart from any other particular theme.

> **"No topic, no agenda, just interesting stories from people you might never meet were it not for the internet"**

Award-winning and compelling, it's innovative in its sound and subjects meaning it absolutely deserves the huge amounts of praise heaped upon it. It's also a good podcast for people who don't get a lot of time for them. Episodes come out once a month and are just 30 minutes long, give or take a few hundred seconds, so you get plenty of time to listen before they start to stack up – and if you've ever tried to follow someone with a weekly release schedule, you'll know nothing makes you quit faster than a pile of unlistened episodes growing quicker than your ability to reduce it.

URL: loveandradio.org

Start With: *The Living Room*, a 2015 Third Coast Award-winner about a woman's very literal window into someone else's life. Compelling and thought-provoking, as well as a little questionable – it'll give you a lot to think about.

Storycorps

A project that began in 2002, Storycorps' mission is to record, preserve and share the stories of Americans from all backgrounds, to create an oral record of the country's culture and history. Unlike most of these projects, Storycorps is specifically designed as a dialogue: typically, interviews take place between two people who know and care about one another, with a Storycorps employee on hand to guide the conversation in interesting directions.

As well as a podcast, Storycorps collects stories in a number of different ways: Mobile booths, door-to-door visitors, and even via an app that allows you to create your own Storycorps-style guided conversations and upload them to the site's archive. There are books, specific community initiatives themed around certain stories – you could spend months lost in the archive alone. Don't let the American-centric nature of it put you off, you'll be engaged with the people and places from the word go.

URL: storycorps.org

Start With: *StoryCorps 436: Great Escapes*, which features the stories of people who got away from some surprising situations, including the incredible tale of Ramon 'Chunky' Sanchez.

Reading Aloud

Although it seems like some might, not all podcasts keep going forever. Reading Aloud, hosted by Nate Corddry, put out 64 episodes before stopping earlier this year – and while in some fields that creates a backlog that goes out of date, there's nothing to stop you going back to the start and enjoying every episode of Reading Aloud in order. Its content isn't especially time-sensitive, so you can take it at your own pace without the feeling that things are getting away from you or forcing you to skip episodes to catch up.

The difference between Reading Aloud and the other podcasts on this list is that it's a storytelling podcast that goes right back to the written word, presenting live renditions of great and interesting works of literature. Most episodes have two guests, some of whom you'll have heard of but many of whom you won't, However, with a large cast of regulars you'll quickly grow to enjoy each one in their own way. The concept is simple, but it works incredibly well, and if you like the format you have days' worth of material all ready for you to work through.

URL: www.earwolf.com/show/reading-aloud

Start With: *Episode 16*, which features Anna Faris reading a hilarious piece live at UCB Franklin in Los Angeles, and then Nate (the host) interviewing his mother before she reads a piece by John Updike.

That's all for this month, but feel free to send in your favourites if you'd like to see them featured. Next month: history. **mm**

The Complete History of Home Computing

Part 4

James Hunt looks at the years 1982 through to 1984

The fourth part of our complete history of home computing starts in 1982. Home computing had finally dawned with the creation of the BBC Micro, the Sinclair ZX80 and the Commodore PET. Meanwhile, the IBM PC had finally made its debut into society, kicking off the platform we know and love today. But it was still early days…

1982

If you needed proof that home computing had arrived, you only need to look at Time Magazine's decision to name the personal computer its 'Machine of the Year' in lieu of having a 'man of the year'. Within 12 months of this, the Time offices switched from typewriters to word processors, digitising its own production methods and putting its money where its mouth was. According to Time, 1982 was the year computers went from being monolithic and inscrutable to true home devices.

Of course, if you had to pick a specific computer of the year, there's absolutely no doubt which it should be: the Commodore 64. Building on the success of the Commodore PET, the C64 had 64KB of RAM, a 6502 processor and the iconic SID chip providing

its distinctive sound. It was instantly popular the world over, remaining in continuous production for 11 years. When it was discontinued, it had sold more than 22 million units, earning it a place in the Guinness Book of World Records as the best-selling single PC of all time – a position it still holds today.

Of course, while the C64 it was popular around the world, the UK had its own home-grown hit, the Sinclair ZX Spectrum, which rivalled the Commodore 64 as the home computer of choice. Although it had just 16KB of RAM, its colour capabilities created a boom in software and games development, and it came out months before the Commodore 64 which, combined with its lower price, gave it a head start that secured its place in the national psyche. As part of the Sinclair boom that virtually created the UK's computer industry, it earned businessman Clive Sinclair a knighthood. In 1983, then-Prime Minister Margaret Thatcher even presented one to Japan as a symbol of Britain's technological aptitude.

On the PC front, February 1982 saw the release of the 80286, a processor you might better know as the Intel 286. Although it didn't set the world alight, it was notable for being compatible with its predecessors, the 8086 and 8088. It had a clock speed of 8MHz and was the first to support 'Protected Mode', which allowed innovations such as virtual memory, memory paging and multi-tasking. You've probably seen those words when you boot your computer, and that's because Protected Mode became the basis for future enhancements of the architecture – although at the time it was first added to the 286, it was not widely used.

Finally, 1982's run of big moments is rounded off by the creation of Sun Microsystems. The first part of its name was an acronym for Stanford University Network, since Sun Microsystems was incorporated by three alumni of the organisation using equipment borrowed from the engineering department. Sun would create the model of workstation-based computers with Ethernet interfaces running on Unix – and, of course, be responsible for the creation of Java in the 1990s. We'll leave it up to you to decide which of these things was more important for computing.

1983

In many ways, 1983 was the year of failed (or at least stalled) experiments, as companies attempted to innovate with ideas that would eventually catch on – just not in the short term.

Hard though it might be to believe, up until 1983, most computers were powered almost entirely from a command line interface. That all changed with the introduction of the Apple Lisa. Named after Steve Jobs's daughter, it was GUI-powered and laid the foundation for operating systems like Windows in the years to come, despite having a 12" black-and-white monitor and just 1MB of RAM. Of course, the Lisa itself wasn't a huge success, with its Motorola 68000 CPU taxed by the complexity of its operating system and a sky-high price. Its $9,995 retail price adjusted for inflation would be closer to $24,000 today!

The first CDs were invented in 1981 as part of a joint project between Sony and Philips. Intended for distributing music, it wasn't long before their potential as a data storage medium was also noticed. The CD-ROM format followed in 1983, and in 1985 Grolier's Electronic Encyclopaedia became the first commercial product using the format. At the time, CDs held the equivalent of 550MB, which was vastly beyond the abilities of even the average fixed disc – though support for the media would take a decade to emerge as any kind of standard.

Software-wise, the year's biggest invention was undoubtedly Microsoft Word. Originally known as 'Multi-Tool Word', the mostly monochrome word processor was the first of its kind from Microsoft. An aggressive marketing push saw 450,000 disks containing a demonstration version being given away. Although it's now synonymous with word processing, it took a while for Word to see off the competition. It wasn't until Microsoft Word for Windows was released in 1989 that it started to look like the industry standard word processor we know today.

▲ *The glory of the Commodore 64*

"Companies attempted to innovate with ideas that would eventually catch on – just not in the short term"

1983 was also the year Richard Stallman, an artificial intelligence processor at MIT's Artificial Intelligence Lab, began developing a free alternative to Unix. Known as GNU (an in-jokey acronym which stands for 'GNU's Not Unix'), it was going to be free and open-source, and it led to the creation of the Free Software Foundation in 1985. But the GNU project didn't really take off initially, and it wasn't until it was used as the basis for Linux in 1991 that it began to reach its potential. Even now, GNU forms a major part of Linux's backbone, which is why it's sometimes referred to as GNU/Linux.

But it didn't all get off to a slow start. The first ever 100% PC-compatible (as in, IBM-PC compatible) computer was released in 1983. It was also one of the first portable PCs, capable of running all of IBM's software *and* being carried around like an admittedly bulky briefcase. Compaq licensed MS-DOS from Microsoft and reverse-engineered IBM's BIOS, racking up first-year sales of $111 million. The Compaq Portable was a huge hit and helped make Compaq one of *the* names in the IBM-compatible market. Indeed, in 1996 it had an 83% share of the market, thanks, in part, to the runaway success of the Compaq Portable.

Clearly, 1983 wasn't the hottest year in computing, with lots of good ideas debuting that would nonetheless take time to prove their worth. But things were about to get serious…

1984

If you've ever decried the way Apple has a Big Brother-like grip over its devices and software, it's hard not to be amused by its famous 1984 advert, which cast IBM as Big Brother and Apple

as a revolutionary, freeing the people from their entrapment. Directed by Ridley Scott and aired on TV just once, during the 1984 Super Bowl, it's considered a turning point for the marketing of computers and one of the most iconic TV adverts of all time.

And what was all the hubbub about? Well, you've probably heard of it. The Apple Macintosh. Like the Lisa, the Apple Mac was GUI powered and came bundled with a mouse. Unlike the Lisa, it was successful. In part that was because it cost just $2,500, barely a quarter of the Lisa's retail price, but it was also because it came with a bunch of free bundled programs like MacPaint and MacWrite, which were early WYSIWYG editors of the type we take completely for granted on modern PCs.

Although it competed with both the cheaper Commodore 64 and IBM-PC with its initial release, the Macintosh became popular in businesses and educational institutions, keeping Apple as the second-biggest manufacturer of PCs for almost a decade after. Meanwhile, IBM was releasing two new machines: the PC Jr. and PC/AT. The former was marketed as a home computer but didn't quite meet the power or pricing required to fill that space. The PC/AT, however, shifted millions of units despite a $4,000 price. As well as having a faster CPU than the original IBM PC (an Intel 286), it also had better storage capacity, more memory and the ability to accommodate high-density 5.25" floppy discs, each capable of storing a massive 1.2MB.

That said, the 3.5" disk was first developed in 1984, alongside other innovations like the laser printer and IDE interface. The biggest new technology to emerge in 1984, however, was flash memory. Presented in 1984 by Fujio Masuoka, who had developed the technology while he was working at Toshiba, flash memory was quickly recognised as a hugely important innovation by the industry. It took its name from a colleague's suggestion, who said that the erasure process reminded him of the flash of a camera. It would take four years for commercial flash products to be developed, though Masuoka's story is an acrimonious one. Feeling that his work has been under-rewarded by Toshiba, he sued his former employer and received an ¥87 million payout in 2006.

The burgeoning industry saw the creation of many popular companies in 1984. Dell was perhaps the biggest name founded in terms of home computing, but the likes of Cisco, Guillemot, Cirrus and Prodigy were also founded. And of course, no history of home computing would be complete without acknowledging the creation of one of the greatest games ever: *Tetris* by Russian programmer Alexey Pajitnov, which was first produced in the USSR in 1984.

▲ ***One of Apple's first systems***

We'll leave you this month with one final, slightly terrifying fact about the pioneers of the computing industry. In April 1984, Bill Gates was featured on the cover of Time magazine for the first time. A month later, Mark Zuckerberg, the inventor of Facebook, was born. And if you wanted to find the most significant event to happen in computing that year, you could rightly argue that it was that last one… **mm**

▲ ***Not exactly svelte but definitely portable***

Remembering... Sound Blaster 16

David Hayward is pitch perfect this week

There were few hardware upgrades for the early 90s PC as impressive as the Creative Sound Blaster 16.

After living with the beeps and shrill whistles of the 8-bit era and being treated to the amazing quality of the Atari ST and the Amiga, the PC finally moved its impressive gaming bulk into the market, and along with it came glorious techno beats and amazing sampling sequences.

The pinnacle of early PC audio hardware was, of course, the Sound Blaster 16. A landmark product for Creative and the company's flagship device, the Sound Blaster 16 soon became the yardstick by which every other sound card manufacturer was measured.

Capable of being able to play and record 16-bit sound, it came with an 18-voice synthesiser chip, the Yamaha YMF262 (or OPL3 Chip). Digital soundtracks and realistic in-game effects were quickly available to all.

It wasn't only games, of course, that benefited from the Sound Blaster 16. Video and music editing finally became a serious pastime on the PC. Professional musicians found a new love for the PC, and the sales of PCs with Sound Blaster 16s already installed helped to create a PC sales booms.

Not surprisingly, despite the Sound Blaster 16 being released in 1992, there were still PCs being sold with original Sound Blaster 16 hardware toward the end of the decade. And, since it was one of Creative's most successful products, the addition of the add-on Wave Blaster and ASP (Advanced Signal Processor) improved the longevity of this ground-breaking sound card.

Its History

The PC speaker didn't evolve much since 1981. Even with the release of the IBM PCjr and Tandy 1000 in 1984, PC sound wasn't a patch on what the 16-bit machines could already offer.

1987 saw the release of the AdLib Music Synthesizer cards, which greatly changed the face of the PC sound market. By the end of the 80s, game developers were beginning to use the improved PC sound cards for their games. Sierra Online was one of the major driving forces behind improving the PC sound card for its expanding gaming line.

In 1989, Creative launched the original Sound Blaster sound card, a card that was fully compatible with the then-leader, AdLib, and including a new generation of digital sound processors.

When AdLib went bankrupt in 1991, Creative took up the mantle of market leader and blew any signs of possible competition out of the water with the release of the successor to the Sound Blaster, the Sound Blaster 16, mere months later in 1992.

The Sound Blaster 16 was a digital musician's dream come true. 16-bit digital audio, FM synthesis, MPU-401 MIDI emulation, connections for those new-fangled CD-ROMs and hardware-assisted speech synthesis had the market drooling.

Although the Sound Blaster 16 lasted far longer than the company ever imagined, it was succeeded just a couple of years later by the Sound Blaster AWE32, a card that improved greatly on the original Sound Blaster 16, but was considered too expensive at the time to realistically replace the SB16.

Did You Know?

- There were three generations of SB16s: CT-1750, CT-2230 and CT-2940. Each had different product numbers branching off from the main CT-line.
- Having the accompanying voice synthesiser program repeat rude words isn't big or clever.
- There wasn't that much of a difference in hardware between the SB16 and the AWE32. The 32 signified the ability to play 32 simultaneous voices via the EMU8000 chip.
- The still used AC'97 codec contains everything the SB16 could do in a single chip – the Realtek ALC658.

The Good

Amazing music and sounds, remember the soundtrack to *Crusader: No Remorse*? Or the *Second Reality* demo?

The Bad

Only emulated MIDI, but the Wave Blaster solved that issue when it was released. IBM Blue Lightning chips could cancel out the DMA settings of an SB16 – especially in *Doom*. **mm**

One of the original Sound Blaster 16 cards

The Creative Sound Blaster 16 was what all modern sound hardware is based on

RETRO ROUND-UP

Dave Edward picks up a Russian first-person shooter, a Spanish car-driving adventure and a Cybernoid clone for the Spectrum. And he discovers the most addictive game ever released for the BBC Master...

Welcome to the Retro Round-Up where, after the last article's catch-up on all things retro-book-related, I once again return to the familiar ground of games. And there have been a lot of them over the last month!

A reader recently asked me how I choose the games for inclusion in each article (particularly in light of the fact that publishers are currently churning out retro games at the rate of about two per day). The answer is that I usually become aware of them in much the same way as I introduce them through this article. The man behind Retro Revisited (**tinyurl.com/zkg9wok**) has a monthly round-up of all the games he's seen; the man behind Indie Retro News (**www.indieretronews.com**) has a daily feed of previews and discoveries he's seen and the forum posts of World Of Spectrum and Stairway To Hell tend to fill in the blanks. I'm naturally drawn more to the new games released either for the systems I've played with, games which appear to be a superior technical feat of programming or games that are based on movies I've watched.

The great news is that, after nearly two years, more and more retro programmers are now aware of these articles. That means I also get the odd nudge via Everygamegoing's Facebook page (**www.facebook.com/everygamegoing**) to review a particular new retro game which, of course, increases its exposure. (At least it does if I like it!) The even better news is that, by the time you read this, I will have added the functionality to the site itself to allow you to request any review of any game ever written, so if you would like to see your new retro game featured in Micro Mart, making a request for it will be only a few clicks away…

This issue, we have a nice selection of very different games, all of which were released in July 2016, a month that seemingly produced over 100 new, fully released games given away by publishers for free and on machines that most people would assume belonged in museums. Let's go…

Car Wars
(El Mundo Del Spectrum, Spectrum 128K, Free, tinyurl.com/h27pdjo)

Car Wars is a new game for the 128K Spectrum, in both English and Spanish, published by Davidian of El Mundo del Spectrum (not to be confused with World Of Spectrum!). It's completely free and introduces itself as "a motor race where you take charge of a car to rival the Formula 1. Overcome each exacting stage – designed to test the patience of the fastest drivers – to win the mayor's bounty".

Given its name (*Car Wars,* in case you'd forgotten!) and the premise, it's not unreasonable to assume the game is an overhead *Micro Machines* clone. The trouble is, it's not; it's yet another graphic adventure built with The Mojon Twins' La Churrera engine, and I've now reviewed so many of these clones – many right here in Retro Round Up! – that my overwhelming feeling on realising it was 'just another Churrera clone' was disappointment.

Chalk through that nonsense about motor racing, and the real premise of the game is to drive around a flick-screen overhead maze collecting coins to acquire a weapon. There are other cars, yes, but they are of the 'patrolling nasties' type: they remain imprisoned on their own screens. As usual with other La Churrera games, you have the patrolling nasties that mill about and the patrolling nasties that home in on you. Here, the second type are helicopters.

When you've collected enough coins to visit the garage, your vehicle is equipped with a weapon, and you complete the stage by retracing your steps through all of the previous flick-screens, getting close enough to a patrolling nasty car to press Space, deploy the weapon and send the car to that great scrapyard in the sky.

If I sound extremely unenthusiastic about this, it's only because I'm still reeling from the misrepresentation of the game as one

Car Wars – a new racing game for the Spectrum. Not

The '?' icons give NES-style tutorials on the first stage

Don't be fooled. None of these other cars move; they're just obstacles

The cautious approach. Clear the area first

The reckless approach. Run!

Screen 15 of 101. Still some way to go...

thing when it's another. Certainly, if you like overhead maze games, you won't find anything wrong with *Car Wars*. It has good graphics, a bouncy little tune, smoothly moving sprites and a rather nice 'tutorial' stage – one more commonly associated with modern titles than retro ones. How to play the game is explained by a series of '?' icons which, when driven over, give you important information what you have to do. Despite the author being Spanish, the information is in perfect English too.

Unfortunately, with a few notable exceptions (*Red Planet*, reviewed MM #1386), I have always found La Churrera games fiddly, with sprites that are difficult to control. *Car Wars* is no exception and, although you might like it, I'm afraid I didn't.

Vallation
(Spectrum 48K/128K, Tardis Remakes, Free, tinyurl.com/j4qrv6q)

Soren Borgquist of Tardis Remakes has a small but quite impressive portfolio of games under his belt. He wrote *The Speccies*, which was released on physical cassette in 2013 and now commands quite a high second-hand price (probably because it's hard to find but very good). He's now back with *Vallation*, a port to the Spectrum of a relatively new shooter for the Commodore 64.

There's no complicated story or misleading blurb here: *Vallation* is an arcade game written in pure machine code. You take control of a small spaceship, and your aim is to cross 101 rooms without using emulator save states (yes, you people know who you are!). Spectrum games players around in the 80s may well remember *Cybernoid*; *Vallation* is the same sort of idea. Each room is a challenge and can be tackled a few different ways. It's not, for example, necessary to kill all the enemy robots patrolling it, because all the game demands is that you cross it. However, some of the enemies can fire bullets at you, so some players may prefer to take these ones out of the picture before attempting to cross the room. Other players may instead accurately time when a robot will fire at them and opt for a kamikaze charge over its head.

I am not sure exactly why, but some parts of *Vallation* feel very much like a 'fairer' version of *Rick Dangerous*. If you're not familiar with *Rick Dangerous*, it was a platform game that invited you to cross rooms without Rick being impaled by hidden spikes, lasers which burst forth from walls or patrolling natives. The difference, apart from *Rick Dangerous* being a platform game and *Vallation* being a shooter, is that *Vallation*'s killing-machine equivalents are not concealed. The rockets, which pepper each wall and burst into life when your ship gets too close, hang there like hunting trophies, forcing you to tiptoe as close to them as you can and then beat a hasty retreat when your pixel crosses a boundary with theirs. This is much less unjust, and *Vallation* never feels unfair. Put in the practise, and you'll win it, although it won't be easy.

When you've crossed a room, you move to the next one. There's no going back. Not that you need to.

Everything about *Vallation* handles very well. The graphics are well designed, move smoothly and react accurately to controls. There's gravity, which means you must hold down the Up game control to make your spacecraft 'hover' (a nice stream of pixels is emitted to show thrust). And there's a lot of colour but no colour clash (always a worry in colourful Speccy games).

The only real criticism, if indeed it even is one, is that *Vallation*'s concept feels dated. While *The Speccies* felt like a brand new concept on the little rubber-keyed beauty, *Vallation* feels like a game that was actually released in 1985/6. If it had, indeed, been released then, however, we would have all been playing it – because it's great. There's some foxy music when it starts up too.

Scores (Car Wars)
Graphics: 63
Sound: 82
Presentation: 37
Overall: 60

Scores (Vallation)
Graphics: 86
Sound: 77
Presentation: 84
Overall: 82

The Dark
(Spectrum 48K/128K, Oleg Origin, Free, tinyurl.com/hlaf336)

Hands up, all of you who like those games where you wander around a 3D landscape with your gun trained in front of you and try to solve puzzles that get you into hitherto locked areas? Yes, *The Dark* is a first-person shooter on the humble Spectrum 48K. The (mercifully short) backstory is that you're a warrior, who has decided to reclaim his mother's land from the 'dark forces'. It's written by Russian Oleg Origin, who also wrote the love-it-or-loathe-it *Metal Man Reloaded*, also for the Spectrum.

The game starts with a prologue, which shows four hand-drawn pictures while telling the story with sampled speech. The speech sounds, for the most part, like gobbledygook, serving only to remind us it's a bad idea to include it. Fortunately, it's over very quickly, and the epic, ground-breaking feat of technical excellence that is *The Dark* begins...

First-person shooters are really nothing without aesthetics. Whether it's the early blocky caverns of *Castle Wolfenstein* or *Doom* or the snow-covered landscapes

That really looks very impressive for a Spectrum...

A smaller monster will suddenly appear much bigger...

...while really big ones appear without warning

of *Goldeneye*, you need some aesthetic appreciation of where you are and how your body relates to the surroundings to effectively weave in and out of the obstacles in your path and make headway. Sadly, the Spectrum is a very limited machine in such a respect. To keep everything flowing at a reasonable speed, you can't fill its memory up with different sizes of sprites, so the monsters of *The Dark* can't come lumbering towards you out of the dark, or from a distance. Instead, they just 'appear' in front of you.

Backgrounds also can't really feature much in the way of texture, because again this would be too memory-intensive, so instead we get drab, washed out walls of blue or yellow that divide up the 3D maze. Move about and the effects are reasonable, the wall shifting its perspective realistically in proportion to the angle at which you are now looking at it. That's good, but unfortunately *The Dark* only has five movement controls – left, right, forward, backward and fire (or poke with trident). There's no sidestep left or sidestep right key, so to move left or right actually means turning left or right and then moving forwards. This, to say the least, is tedious, especially when one of the game's monsters barrels down upon you. You end up backing away and firing furiously at it – but you can quite easily end up backed up into a corner with nothing to do but pray.

There are also odd effects that render *The Dark* more difficult to play than you would expect. A periodic aim is to collect the keys that hang on the walls, and a typical level involves fighting your way through the monsters and heading down a long foreboding corridor, where a key hangs on the wall that represents the dead end. If you approach the wall while in the centre of the corridor, the key remains visible. Come at it from a different angle and the key may well appear and disappear with each footstep you take toward it, because the perspective of the tilted wall obscures the item.

Enemies, on the contrary, appear in black 'blocks', which obscure any walls behind them!

There are some aesthetics of *The Dark* that do work well, though. When under attack, your vision turns blood-red. When you start the game, you don't actually have a gun, and the game makes you work to find it. You will also intuitively reference the status bar at the bottom and the map at the top (called up with the spacebar) without realising. The sound of your footsteps is a nice touch, and the scale of notes that accompanies the appearance of a monster manages to jar, even though it's quite a simple effect.

As with *Metal Max Reloaded*, *The Dark* is hard. Very hard. The monsters will quickly pick you off unless you kill them or run away very fast, and if they don't, the lack of being able to understand what to do and where to go to escape from a seemingly closed-up maze might well see you reaching for the reset button before too long. I did.

But let's get one thing straight. *The Dark* is an immense technical achievement on the 48K Spectrum. There's no denying that. It may struggle with the limitations of the hardware of the machine, but when you consider how varied and complex the calculations have to be to generate a realistic first-person perspective in 48K, you realise that it's both amazing, and it will likely stand almost alone in such a genre for that machine.

The trouble is that playing *The Dark* isn't the pleasure you might imagine, because the aesthetic faults are likely the very reasons why other publishers never even attempted such a feat of programming. Due to their different architecture, computers like the Commodore 64 could handle a 3D maze-based first-person shooter gracefully (yes, even in 1984/5 – look at *Way Out* (**tinyurl.com/glowtxh**). The Spectrum could not, and it probably never will. *The Dark* is probably the best first-person shooter it is ever going to see.

Whether you consider it worth taking on the dark forces inside your Spectrum really depends on whether you see the existence of a first-person shooter for the Speccy as worthy of being played in its own right... or as a game that you want to win. By all means, download it if you fall into the first category. But if you fall into the second category, to quote Pierre Bosquet, "C'est magnifique, mais ce n'est pas la guerre: c'est de la folie." (That's "It's amazing, but it's not war; it's madness," to non-French speakers.)

Scores (The Dark)
Graphics: 70
Sound: 31
Presentation: 55
Technical Achievement: 100
Overall: 64

Sugar Smash
(CRTC, BBC Master 128, Free, tinyurl.com/hc6jyg4) – Retro Find Of The Month

Anyone who has even a passing acquaintance with iPhones, consoles or even pub quiz machines has likely come across either *Candy Crush* or *Bejewelled*. Both are simple, grid-based games, in which you're given a grid of icons and must create lines of three by switching one icon with one of its neighbours. *Sugar Smash* is essentially *Candy Crush* ported to the BBC Master, and

▲ *Cages prevent sweets falling below a certain level*

▲ *And – boom! That'll take out that cinnamon whirl to the left*

▲ *And – boom! That'll destroy that cage… All part of the plan, really*

it features everyone's favourite lozenges, gob-stoppers, jelly beans and fruit drops, all just waiting to be flicked back and forth.

The original *Candy Crush* was so addictive that there were reports in early 2010 of players seeking professional help to stop playing it. If those reports are true, I suspect some of you reading this will drop your Micro Mart and rush over to the above link the very instant that I reveal that, if anything, *Sugar Smash* is even better than the original. Indeed, it's been a long time since I became furiously addicted to a particular retro game, but ever since I discovered *Sugar Smash*, it seems that a day must not pass without me not having cleared another grid of fruits of those ones encased in jelly.

If you've read the above two paragraphs with very little idea of what I'm talking about, then basically, each level of *Sugar Smash* starts by displaying a 9x9 grid of sweets. Some of the sweets may be encased in jelly (signified by a 'dithering effect' and border) and others may, on later levels, be imprisoned in cages. The object of the game is to remove the sweets that are in jelly. Your task is to try to formulate a plan to work two sweets of the same type over to the jellified version, then get them all together in a line of three to blow them all up and increase your score. You have a set number of moves (depending on the level of the game you've reached), within which all the jelly must be removed.

For a game with such a fabulously simple concept (line up three sweets in a row and they explode), it's actually quite difficult to put one's finger on why the game seems to delight everyone who plays it in equal measure. The elements of the game tend to reveal themselves as you start playing it, and discovering them is part of the draw factor. But just some of these elements are: a line of four sweets of the same type (by accident or design) explodes three of them but creates a 'supersweet' that destroys a whole row or column; a line of five sweets creates a 'bombsweet', which destroys every sweet on the entire grid with the type it's switched with; the cages that get in the way; the cinnamon whirls that can't be moved at all but can be blown up if on the periphery of an explosion and, most importantly, the chain reactions that any move can potentially ignite.

The grid has gravity, which means every switch that removes sweets causes any of the sweets above to fall into the gaps created. In turn, these new sweets may match with their neighbours, exploding yet more sweets. These chain reactions rack up points and, in *Sugar Smash*, create explosions that get louder and louder until your BBC is almost airborne. But lots of chain reactions isn't necessarily good news, particularly if you had a grand plan to get certain sweets over to certain sections where they were needed to match with jellified ones!

It seems to be all of the elements combined that makes the concept so startlingly addictive – and the game so difficult to put down.

Sugar Smash is played with the arrow keys and the Return key and must qualify as one of the best retro releases this year, if not the best BBC Master game ever. The only real problems are its limited sound, lack of title screen, lack of instructions, the complicated loading instructions (see the above link) and the fact that it doesn't work on the original BBC Model B or Electron. The latter is probably because it runs in the BBC's highest resolution (seven colour!) mode.

Sugar Smash was actually released in July 2016, but its release could not have been more low-key. I only became aware of its existence when reading about the Sundown 2016 demo party, where I found it came fourth in the 'Wild Demo' category. Publisher CRTC needs to get word of it onto a few forum posts as quickly as possible!

Scores (Sugar Smash)
Graphics: 60
Sound: 30
Playability: 100
Technical Achievement: 100
Overall: 72

That's All Folks!

Before signing off this article, a big thanks to Terry Stewart for confirming that, in the game *Jet Set Billy* (for the Colour Genie, as reviewed in MM #1426), the main character can indeed shoot arrows from the outset. The game control key to do so, if you're playing via the Genieous emulator (which of course, you will be), is Insert on a modern PC keyboard. So if you've ever fancied playing a more bad-ass version of *Jet Set Willy*, I'd complete that review by giving *Jet Set Billy* an overall score of 57%.

Oh, and one more thing. The eagle-eyed of you may have noticed that *Vallation* came in higher than *Sugar Smash* with its overall score, and you may therefore wonder why it's not Retro Find Of The Month! Well, *Sugar Smash* is the better game, but the scoring system requires me to rate graphics and sound equally but playability separately. Now I know why many magazines also had a 'Lastability' element too. For this issue, you'll have to forgive it. Next issue, I'll be adding 'Lastability' so we don't have that situation again.

As Arnie used to say in the 80s, I'll be back…**mm**

Linux: From A-to-Z

David Briddock continues the series with the letter E.

This week's topics are executable files, the Emacs editor, LPI exams and the /etc directory.

Executable

The power of Linux is down to its extensive collection of executable files. Many are platform-compiled C language programs, utilities and tools whose origins can be traced back to the 1970s and the earliest days of the UNIX operating system development.

But there's also a large collection of executable shell scripts. These scripts contain Linux commands bound up within a scripting syntax. This syntax includes loops and conditional statements, which means these scripts are effectively mini executable programs.

Most importantly, anyone can create a shell script. All you need is a simple text editor, like Vi or Nano. To run your script, you'll need to first assign executable status to your file. This is done with the 'chmod' terminal command.

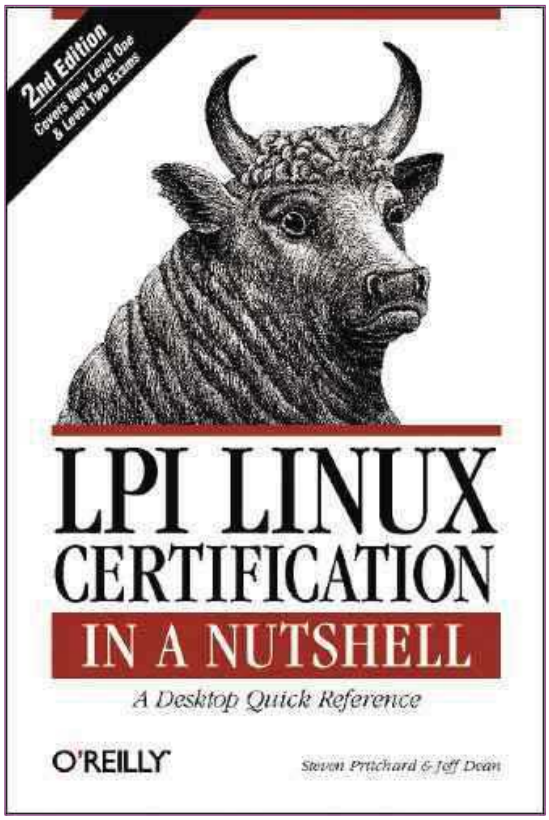
Emacs

There are two classic text editors that go right back to the early days of UNIX development. One is the relatively basic yet easily learned Vi editor. The other is the all-singing-all-dancing Emacs (**gnu.org/software/emacs**).

Emacs is a functionally rich program that offers immense editing power and flexibility. In fact, there are over 2,000 built-in commands. These commands can be strung together to define even more powerful macro commands, and the emacs program itself can be extended via Lisp language coding.

However, Emacs isn't a particularly friendly editor for Linux newbies, especially those who've been brought up on graphical user interfaces. In particular, there's a daunting list of special key sequences to learn to take full advantage of all its built-in features.

However, modern Linux distributions invariably contain a GUI-enhanced version of Emacs, which offers a more familiar menu-driven interface plus a collection of clickable icons for the most useful tasks.



LPI Certification In A Nutshell book

> **Emacs is a functionally rich program that offers immense editing power and flexibility**

Exam Certification

Thinking of a career as a Linux administrator? Then maybe you'd like to demonstrate your Linux knowledge and skills to a future employee by passing the Linux Professional Institute (LPI) certification exams (**lpi.org/certification**).

Some of the key LPI certification topics are Hardware, Architecture, Linux Installation, Package Management, Linux/GNU Commands, Devices, Filesystems, Networking, Web Services, Security and the X-Window System.

Once of the best investments for those seeking to pass this exam is the O'Reilly LPI Certification In A Nutshell book (**goo.gl/TLJzEV**). All the topics are covered in detail, plus there are plenty of review questions and hands-on exercises.

Etc Directory

The /etc directory and its sub-directories are where you'll find the system configuration files. These text files effectively control the operation and behaviour of many essential Linux programs. For this reason, it's a good idea to back up this directory on a regular basis.

Here are some of the most important files. The /etc/passwd file contains essential information for each Linux user. Inside the /etc/fstab file is a table of devices that will be mounted when the system boots. The /etc/hosts has a list of network host names and IP addresses.

Each /etc sub-directory typically hosts configuration files for a specific area of the Linux system. Examples include system fonts, X-Windows setup, Bluetooth wireless communications, printing (CUPS), auditing and security. **mm**

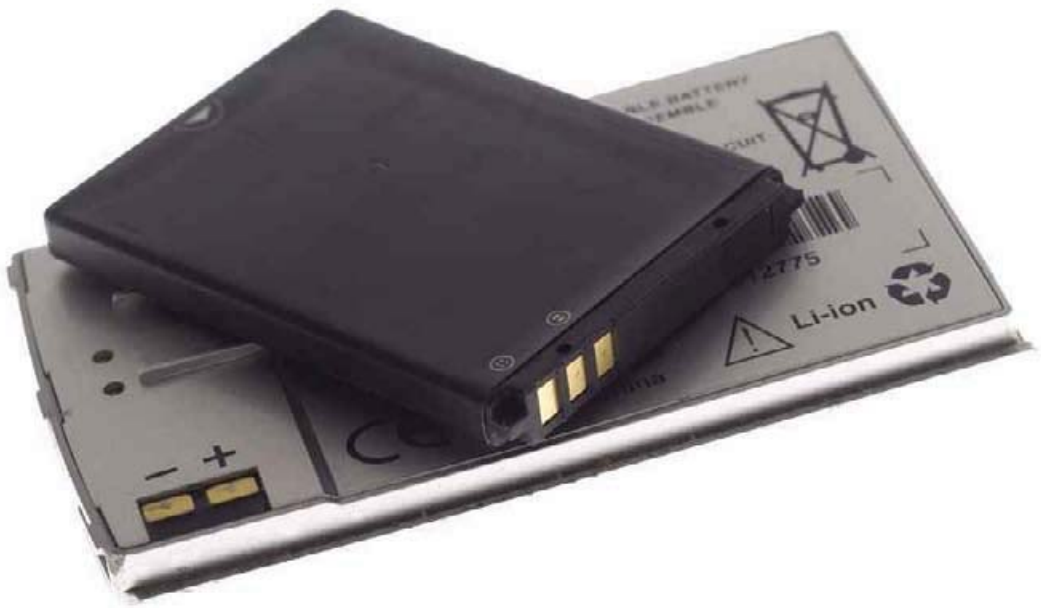
Your Letters

Batteries

I've read your piece on page 37 of issue 1432, regarding battery issues. I'm on my second BlackBerry, a 'Classic', and it has the great advantage of fitting my shirt pocket while being fine for making calls, texts, emails and looking at the web. But unfortunately BlackBerry fell into the trap of following Apple, and the battery is not user replaceable. My previous model, a 9500, not only offered this feature, but I also have a holder for carrying a spare battery and within which the battery could be charged when not in the phone. Surely far better to swop out a flat battery and replace with a fully charged one, rather than having a separate power bank and a bit of wire, and waiting while recharging an internal battery? Not to mention Samsung's predicament... I bet they wish they could swop out a battery. And of course even rechargeables don't last forever, and start losing their capacity after a time. Why do we need to send it to a workshop for replacement?

As an engineer, I really cannot understand Apple's fundamental approach to new models. I've never, ever, heard anyone say 'I wish I had a thinner phone', while many despair over battery life. So why promote a new phone as being thinner (and therefore probably more prone to damage) instead of maintaining the same profile while enclosing a bigger battery? It doesn't make sense. My BlackBerries both feel reassuringly robust and are easy to hold. And I find that having emails pushed to me means that I can use the phone to delete any dubious communications before downloading and opening them on my PC.

Peter Heaven



Am I Being Cynical?

After the recent purchase of ARM Holdings by Softbank, I started to think what a wonderful idea if Intel bought ARM from Softbank for 26 to 30 billion or so then shut ARM down. It would benefit both Softbank and Intel, getting Softbank out of its debt and Intel rid of a rival and getting the intellectual property held by ARM at a knockdown price. Then all manufacturers who now make or use the ARM chip having to pack in or beg Intel to use their overpriced chips. Which leaves our pathetic governments spluttering, as it did when other foreign companies bought our companies, promised to keep them open, then shut them down. Chocolate, anyone? I wonder how long it will take.

Dave Shaw

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Mental Health & Technology: What's On The Market?

Rob Leane has a look at the websites, apps and devices aiming to help with mental health conditions...

Depression, anxiety and other mental health conditions affect a huge number of people worldwide. It's no surprise, then, that a variety of websites, apps and devices have sprung up offering to help those afflicted by these invisible illnesses.

In fact, there's so much on the market that it's hard to see the wood for the trees. What app is actually right for you? What's the difference between all the websites offering advice? If you've pondered these questions, hopefully our guide to what's on offer can help...

If You're Unsure Of Where To Start

If you think you might have a mental health condition, trying to find out what to do can be very daunting. Where do you start when there's such a groundswell of information online?

Samaritans, a registered charity that offers support to anyone in emotional distress – is certainly one option for a starting point. If you Google 'Samaritans signs you might be struggling', the first page that comes up is a very helpful one. Click that first link, and you'll find some friendly advice, things to watch out for and a big green 'contact us' button. If you click that button, you'll find an email address, a phone number and a postal address. Samaritans is manned 24/7, 365 days a year, and its staff are trained professionals.

> **"There are apps that offer to assess your risk of depression, based on the symptoms you're feeling"**

There are also apps that offer to assess your risk of depression, based on the symptoms you're feeling. These include WhatsMyM3 and Depression Test, both of which are available on Android and iOS and have more positive reviews than negative ones. These apps don't offer treatments, but finding out which condition is affecting you is an important step in the process of tackling it.

If You're Looking For Online Help

The internet can be an intimidating place, but there are some friendly corners of the web that truly want to help with any mental health-based issues that you're going through.

If you search for 'NHS online mental health, the first link (which isn't an advert) that comes up is entitled 'Introduction – Online mental health services – NHS Choices.' If you click on this link, you'll be brought to a page that simply summarises a collection of online options when it comes to seeking mental health help. These include the websites Big White Wall, FearFighter, Kooth, SilverCloud, Sleepio and Ieso. If seeking help online sounds less daunting than talking to your GP, it's worth taking a look at this NHS web page and deciding which of the options best suits your needs.

Mind, another UK charity focused on mental health, also has a lot of information available online. If you search Google for 'Mind information and support' and click on the first non-advert link that comes up, you'll find a page that clearly lays out Mind's services. These include guides, helplines, information and a fantastic online community called Elefriends, which offers a safe place to chat with people in similar situations to your own.

Speaking of friendly communities, it's also worth mentioning DenOfGeek.com's 'Geeks Vs Loneliness column'. Search Google for 'Geeks Vs Loneliness', click the first link, and you'll find a plethora of friendly articles that offer tips for dealing with all sorts of mental health difficulties. Under each article, Den Of Geek's friendly reader community offer a welcoming comments section that is moderated carefully by the site's editor (one-time Micro Mart editor, Simon Brew). Here you can talk about your own experiences without the fear of being ignored, ridiculed or trolled.

Also, if you've been prescribed medication to aid with your mental health, but feel wary about it, there's an app that can explain more about what this medication is and what it does. It's called Psych Drugs & Medications: Prescription Psychiatric Medication Pocket Guide In Psychiatry. Searching just 'Psych Drugs & Medications' will bring it up on the Apple App Store and Android's Google Play equivalent. At the time of writing, this app has many favourable reviews.

The NHS's Notes On Apps

If you've tried looking for mental health apps yourself, you'll know that there's so much on the market that it's hard to know which to pick. While researching this article, I stumbled across a very helpful NHS web page that lists a lot of these apps, the prices attached to them and the exact services they offer. If you'd like to know more about what's on the market, then I'd highly recommend searching Google for 'NHS smartphone apps mental health.'

One of the top results is entitled 'Smartphone "Apps" For Mental Health – NHS Borders'. When you click this link, you'll be presented with a PDF file from the NHS that details "a collection of apps that [they] have seen and consider to be potentially useful", which aim to "deal with mental health issues".

The page is handily divided up into Apple and Android sections, meaning it's likely that you'll find something that's available on your particular brand of mobile by taking a few minutes to peruse this page. As well as information on pricing, the PDF also explains what each app actually does and whether it can be password protected.

In the Apple apps section, you'll find Thought Diary Pro ("allows you to record your thought, your mood and your physical sensations" to "identify any thinking errors you may be making and come up with a rational response"); iCBT (much the same as Thought Diary Pro, but with a password protection option); Behavioural Experiments (all about monitoring behaviour and its outcomes, suitable for anxiety and depression)' iCouch CBT ("gives a good outline" of the Cognitive Behavioural Therapy model); and Mood Master Anti-Depression (which offers more CBT treatment suggestions as well as "an interactive function that allows users to record situations, their mood and a 'learning point'").

On the Android side of the fence, the NHS app list includes Cognitive Diary (which "gives an overview of Cognitive Behavioural Therapy and explains how to challenge thoughts", as well as offering a place to log them); Depression ("Users can rate mood and can be guided through challenging their thoughts"); The Worry Box (allows the user to "record worries, label worries as important on unimportant, controllable or uncontrollable", alongside some "audio relaxation exercises"); and T2 Mood Tracker (which "can be tailored to any disorder", and allows users to "rate their anxiety/depression levels on sliding scales" as well as adding notes "to monitor triggers to specific moods").

Sadly, there are a few other apps on the list that seem to have been removed from the market since the NHS's PDF was published. But still, it's worth having a look at this list if you'd like more information about mental health apps and which ones could be relevant to you.

General Apps

That NHS list is far from extensive, though. I found tens more while compiling information for this article,

from wide-reaching general ones to very specific ones applicable to certain conditions. First, I'll go through the broader options. All of them are available on Apple and Android devices unless I state otherwise.

Health Through Breath has a wealth of highly positive reviews. It lists depression among the conditions it aims to help with, and offers "a simple and intuitive guide to deep breathing that features a progressive course based on the principles of yoga to help you find balance and stress relief."

Positive Thinking – The Key To Happiness takes less of a scientific approach than some of the others I've mentioned, but seems to have earned some praise for offering inspirational quotes as well as detailing "the method to grow positive thinking" and offering advice. Live Happy is an app that allows you to sign up for a subscription to receive articles on happiness regularly.

Positive Activity Jackpot is an Android exclusive (although there do seem to be people online offering ways to get it onto an iPhone; just search 'Positive Activity Jackpot iOS', and it's the first thing that comes up). It "uses a behavioural therapy called pleasant event scheduling (PES), which is used to overcome depression and build resilience." It also "features augmented reality technology to help users find nearby enjoyable activities."

Happify takes an interesting approach, offering "science-based activities and games to elevate happiness" as well as the ability for users to "choose a personalised happiness track [which seems to be a goals system] created by experts." It lists stress, anxiousness and depression among the issues it's trying to help with.

Smiling Mind is a not-for-profit organisation. Its app was developed by psychologists and educators and offers tailored programmes for all ages to assist with unhappiness. It uses meditation, mood charting and progress-tracking charts, and seems to be rather popular.

Mood charting seems to be one of the most common features of this app, which is because it's such a core part of cognitive behavioural therapy, one of the most commonly taken routes to try to alleviate depression. T2 Mood Tracker and Optimism (the latter of which is an Apple exclusive) are two examples of apps that focus entirely on mood charting.

MoodKit is another example. It's an app that boasts over 200 mood improvement activities, integration into your calendar, a collection of custom journals and the ability export your mood charts. It has one of the best aggregated user review ratings of all of the apps that I've looked at while putting this article together.

The More Specific Apps Available

Speaking of apps with great review scores, MoodTools: Depression Aid has also won plenty of acclaim from its users. This app – the first in our section on the more specific services on offer - allows sufferers of depression to chart their thoughts, develop plans for the future and increase their understanding of the condition through information, videos and tests.

Depression CBT (an Android exclusive) is similar to MoodTools, but with relaxation audios and articles about clinical depression included.

"Devices are becoming increasingly prevalent in the field of mental health treatment"

Pacifica is another app that has garnered overwhelmingly positive reviews, and it's also earned no shortage of critical acclaim (everyone from BuzzFeed to Forbes has sung its praises in recent months). Designed for sufferers of stress, anxiety or depression, Pacifica offers a bit of everything: mood tracking, relaxation audios, thought analysis, daily challenges, health tracking and even the ability to set up a private chat with a friend, therapist of family member to talk about your progress.

If you're plagued with insomnia or another form of sleep deprivation, there are a number of apps on the market aiming to help. If you search for 'Insomnia apps 2016' on Google, the top result is a Healthline.com article that compares many of them. Sleep Cycle – which uses your phone's microphone to scan your behaviour in the night – seems to be the biggest name in the business, with plenty of positive notices.

Worry Watch is aimed at people suffering from anxiousness. It's an app that expands on the idea of mood tracking, allowing its users to note down things that bother them, analyse them later (to see if things turned out as bad as expected), look at trends (are most of your worries unfounded or not?) and – if all goes to plan – change people's perceptions of what's worth worrying about.

Panic Relief was made by Danish psychiatrist Marianne B Geoffroy to inform and assist those of us who suffer from panic attacks. Using four short cartoons, the app explains what a panic attack is and offers suggestions on how to tackle them.

Rise + Recover (or Rise: Eating Disorder Help, as it's called on Android devices) is a monitoring and management tool for those who suffer from eating disorders. You can use the app to log your meals, set reminders, receive inspirational quotes and access a wide range of informative resources.

Sober Grid is a social networking app for people recovering from alcohol or drug addictions. It can be used to build a network of people near you going through the same thing, with a chat function, a GPS interface and the option to alert the community and ask for help when you're having a 'burning desire.'

Live OCD Free is an Apple-exclusive app for people with obsessive compulsive disorder. It uses goals and rewards to "help create exercises to diminish OCD symptoms." On Android, there's an app simply called OCD, which teaches its users "calming activities" to help them find a method that works for them "for resisting the rituals or compulsions."

PTSD Coach was designed by the US Department Of Veterans Affairs and is now available around the globe for sufferers of post-traumatic stress disorder. It offers information, self-assessment and tools to "help users manage the stresses of daily life with PTSD." These tools "range from relaxation skills and positive self-talk to anger management and other common self-help strategies."

The US Department Of Veterans Affairs has also developed CPT Coach (currently an Apple exclusive) "for patients to use with their therapists" during face-to-face cognitive processing therapy for PTSD.

Are Devices The Future?

Devices are becoming increasingly prevalent in the field of mental health treatment too. There's the Q Sensor, for example, a small wristwatch-sized item that measures and records physiological behaviours that link to psychological conditions.

The Pip Biosensor is another example: it's a tiny egg-like device that you hold between your thumb and forefinger when feeling stressed. It scans your skin pores, measures the physiological changes and connects to an app on your phone or tablet stuffed with analysis, relaxation tips and helpful data.

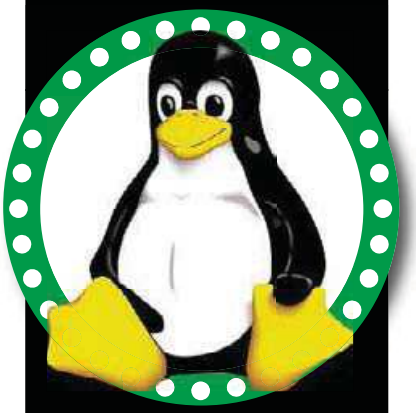
Beyond Verbal is an 'emotional analytics company', which has developed a software for phones, smartwatches and so on that will monitor your voice for changes in tone to detect mood shifts, before offering a "comprehensive overview of emotional wellbeing over time". It's not available to the public yet, though.

The Spire Stone (available now at an RRP of £119.95) is a 'mind and body tracker' device with a companion app for the iPhone. "Unobtrusively clipped to your trousers or bra, the tiny Spire Stone senses respiratory patterns to detect changes in your state of mind", the official website tells me. "With gentle notifications, rich insights and breathing exercises delivered on your iOS device, Spire unlocks a more mindful, balanced and productive day."

There's also the Fisher Wallace Stimulator, a handheld device with a headset attachment to be used for 20 minutes a day that "uses patented waveforms to gently stimulate the brain to produce serotonin and other neurochemicals responsible for healthy mood and sleep." It's primarily designed for people with depression, insomnia or bipolar disorder and has been found to be effective in recent studies.

There are more mental health devices on the way, as well. Here in the UK, the University of Nottingham's NHS-aligned research team (known as the MindTech Healthcare Technology Co-operative) is currently exploring the "potential of wearable devices to help prevent and treat depression.

Of course, there is no one-size-fits-all solution for mental health conditions. But, hopefully, if you're affected by any of these invisible illnesses, you might find something helpful if you try out some of the websites, apps and/or devices that I've mentioned in this article. **mm**



Linux And Lenovo

Lots of flames this week

David Hayward has been using Linux since Red Hat 2.0 in schools, businesses and at home, which either makes him very knowledgeable or a glutton for extreme punishment

There are many passionate, dedicated people within the Linux community, from developers to regular users. Sometimes, though, that passion can be a problem, especially when it overspills into anger, as it did recently among certain sections of the open-source community.

The outrage stemmed from reports suggesting that users are unable to install Linux on new Lenovo laptops. The wrath of upset Linux fans was quickly felt, and blame was firmly aimed at a variety of companies – largely, as it turns out, without justification.

The Blame Game

First, the vocal element of the Linux community blamed Microsoft. Somehow, it was said, Microsoft had built in some kind of magical feature that could stop someone trying to install Linux on a Lenovo laptop instead of Windows.

Next up, Lenovo was blamed for working in cahoots with Microsoft in some sort of clandestine tryst dedicated to bringing the Linux community to its knees, ensuring nobody would ever enjoy Linux on one of its laptops. Then, finally, Intel took a hefty chunk of the blame, with some members of the community stating that the company must have purposely introduced a feature that can stop any Linux distro being installed on Lenovo's laptops.

That's a simplified version of events, as a few other companies came under fire along the way. Nvidia got a bit of hate, and I believe the NSA got a mention too because it wants to stop people using Linux so it can see what we're all up to.

The Real Problem Is...

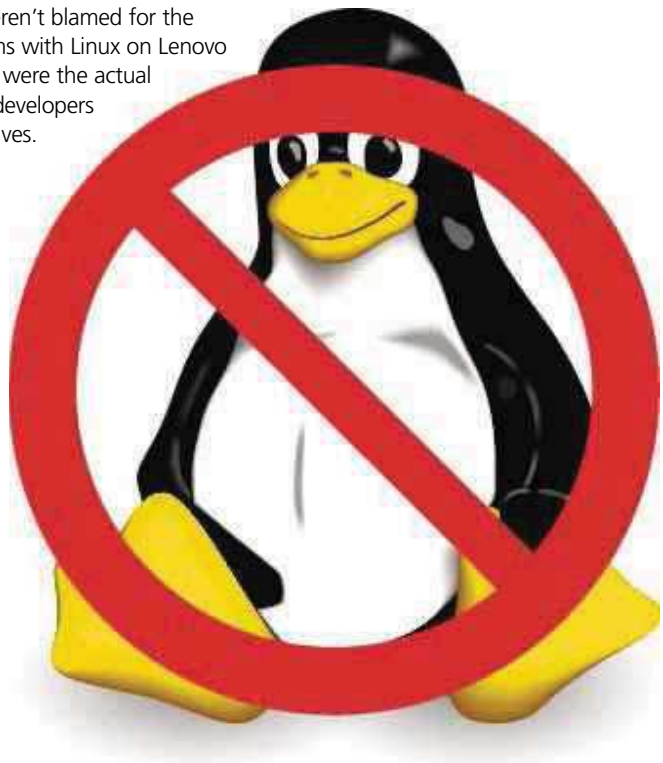
However, According to experts, the real reason Linux won't install on a modern Lenovo laptop is down to the fact that the company now uses RAID on SSDs, and Linux doesn't support SSDs in that mode of operation. While it is able to see the SSD when it's in AHCI mode, new Lenovo laptops can't disable the RAID mode due to their new Intel technology operating at the BIOS level.

Sure, you can point the finger at Lenovo for using a new Intel technology, or Intel for creating it, but the real problem is that Linux developers haven't got around to making the kernel compatible with the new way of working. It's actually quite amusing if you stop for a moment and take it all in. The only people that weren't blamed for the problems with Linux on Lenovo laptops were the actual kernel developers themselves.

Of course, you could aim some criticism at Intel for releasing the technology without having checked it would work with Linux first – that's probably worth a little bit of your ire – but SSD and RAID have been around for a while now, so perhaps the kernel developers should have been more on the ball too?

As with most new technology that comes around, there's usually a period of time when something doesn't quite work as it should. It generally doesn't last long, though, it just takes a while for all the various developers to get behind the hardware. In short, is it really worth the amount of anger we've seen over the last week? I don't think so.

Got a new Lenovo? Want to install Linux? Not yet you won't



A Death In The Family

Cheerio, iMac – it was nice knowing you, but now you're going to the scrapheap in the sky

I bought my first Mac in the 1990s. It was a PowerMac 8600/250AV that was approximately 75% Mac and 25% sociopath. At inopportune moments, it would kick up a fuss and keel over. For good measure, the internal Jaz drive (one of the most abhorrent storage options in the history of computing) would do the same, frequently leaving the computer entirely unusable.

Still, after making minor repairs to have everything actually work like it should have done in the first place, I managed to sell the thing, and the same's been true for every Mac I've owned since. In part, this is because I take good care of my Macs. Also, Macs tend to be built to last. Furthermore, I used to upgrade my Mac every few years, to keep things current, so they never got too old in my employ anyway.

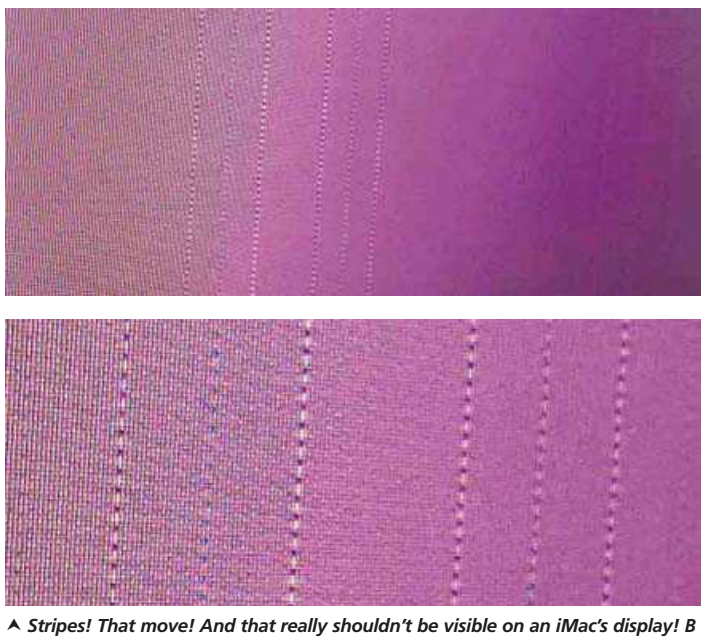
Things change, though. Over time, Macs have become more powerful, and so potentially last longer. Also, my work has shifted dramatically from design to writing, to the point I don't need cutting-edge tech; in fact, at a pinch, I could probably do quite a lot of my work on a Commodore 64. Then there are other devices clamouring for my money – iPhones and iPads, the Apple Watch, and Android kit. Since I spend more of my time writing about mobile than desktop these days, a new iPad isn't a luxury for me, but instead a piece of required equipment. Juggling upgrades therefore means something has to give, because I'm not made of money – and what has given is the Mac.

This all leads us to my current situation – one that is entirely new. A few weeks back, I noticed some weird lines on my 27" iMac's display. On closer inspection (as in, shoving my nose up to the glass), I saw what looked like lines of dots marching upwards every centimetre or so across the entire screen. As those in the know will be well aware, this usually means one of two things: a GPU failure or a dying display. One quick test on an external display later and my iMac's symptoms were all but confirmed: the screen is a goner.

As I type this, it's not dead just yet. In fact, from a typical working distance and when using a light background, you'd be hard-pressed to tell anything is wrong. But when doing anything with graphics on backgrounds of a darker hue or even working in Slack with its purple sidebar, those marching dots become readily apparent. This means I have a Mac that, for the first time, I won't be able to sell in its complete form – it's the first Mac that won't be waved off to a new home, but will instead end up stripped for reusable parts and sold off where possible.

It's a sad end for a machine that's put in sterling service. Its SSD will be repurposed in a newer, sleeker iMac, and the RAM will be hurled in the direction of eBay. I might even sell the rest of the thing for parts. I even have the box in the loft.

This shows that even hardier computers don't last forever. Most people I know with Macs or PCs are quite surprised to find I'm still using a six-year-old machine, and would happily to use it for another six if I could, but Mr Stripy here has other ideas.



Stripes! That move! And that really shouldn't be visible on an iMac's display! B

Craig Grannell is a writer, designer, occasional musician and permanent loudmouth. He's owned Macs since 1996, when Apple was facing certain doom, and is therefore pleasantly surprised by its current success. Find **Craig** on Twitter at **@craiggrannell**

Lost In Time

Ian McGurren takes a look back at Google's flagship phones

The Nexus is dead, long live the Nexus. Yes, if you've been party to the Android rumour mill, you notice that while Google is sticking to its yearly hardware release schedule, there's a name appearing more than in previous years – 'Pixel'. The Pixel line isn't new, but until now has been kept to high-end Chromebooks nobody can afford and a quietly released tablet. However, 2016 may well be the year the Pixel name steps to the fore – and the year the Nexus name starts to step down. So over the next two weeks, we will take a tour around the Nexus phones that have served many of us well over the years.

The debut of the Nexus line came in the form of the Nexus One itself, one of the first devices to demonstrate that Android could have what it took to take on the iPhone. Built by HTC and released in early 2010, the specs now seem pedestrian – 3.7" 800x480 OLED screen, 1GHz CPU, 512MB memory and Android 2.1 Éclair, and it wasn't freely available at retail. However, repackaged as the HTC Desire, it was a definite contender and arguably the first 'big' Android handset that could offer an alternative to Apple, and opened the floodgates of the free-to-license OS to appears on more hardware than any other mobile OS.

> **"2016 may be the year the Pixel name steps to the fore"**

Late 2010 saw the release of the Nexus S, the second Nexus device, and the first to run Android 2.3 Gingerbread. Like its forbear, it was based on a retail device (here the Samsung Galaxy S) but this was the first Nexus available at retail (though only at Carphone Warehouse and not yet via Google itself). It was a mild boost in terms of hardware and didn't bother the top seller of the year lists.

So, in 2011, it came to be that the Galaxy Nexus – also from Samsung – was the first device (alongside with its Nexus 7 tablet cousin), that could be purchased from the Google Play store, SIM and contract free. The Galaxy Nexus also claimed other firsts: the first device to have unique hardware not based on a retail device, the first Nexus with a HD screen (1280x720 AMOLED), the first to have a dual core CPU, and – along with the Nexus 7 – the first to run the unified phone and tablet Android (4.0 Ice Cream Sandwich). Even some of the success of Samsung's Galaxy SII, the closest to the Galaxy Nexus in terms of specs, seemed to rub off on Google's device.

Though by 2012 Nexus devices had been made by a few manufacturers (HTC, Samsung, Asus), the Nexus 4 was to introduce LG to the fold. Based on their Optimus G platform, the Nexus 4 was a step up in terms of quality with its gorgeous rounded glass screen and reflective rear. Battery life wasn't the best, however, at least with the pre-installed Android 4.2 Jelly Bean, though this did increase with the next OS. The big success for the Nexus 4 came at the end of its life, when Google decided to clear the shelves in preparation for the next Nexus and the 4 could be had new for a paltry sum. Stocks didn't last long.

That's it for part one, where we've seen the Nexus line slowly come to life, first as a phone for the tech crowd, to a vanguard of an operating system growing in power, popularity, and value – all without cutting corners.

▲ xxxx

Ian McGurren is a professional IT analyst, a semi-professional writer and a pretty amateur electronic musician. He likes gadgetry and loves making gadgets do things they were never designed to do

Mobile

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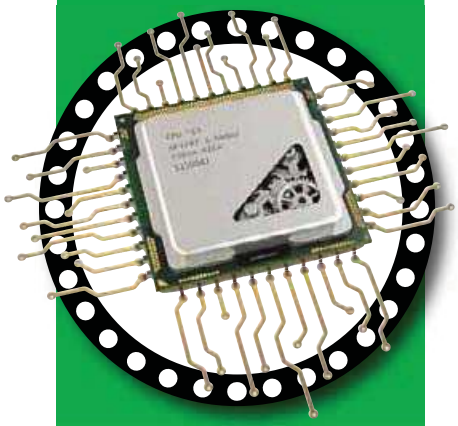

Thinking of getting satellite TV? Andrew Unsworth gives you some options

When it comes to watching TV, there are more different makes, models and screen sizes than ever before. At one time, the main aim of buying a TV was to get one with Teletext and stereo sound. For those with a little more knowledge of TV technology, opting for a 'flat' screen TV, such as a Sony Trinitron, might have been a good option. Of course, those were the days of the cathode ray tube (CRT), so a flat screen meant exactly that; it didn't mean you'd get a flat TV. We had to wait until the late-90s for something that approached that aspiration, and then the mid-2000s before such things became affordable for the masses.

Roll on a couple of decades and there are many different types of TV technology: LCD, plasma, rear-projection, and even good-old CRT (even I've still got one of those). High-definition home cinema projectors are increasingly popular, too.

However, not only is the media through which we watch TV diverse, the method of putting images on our screens also varies wildly. The most obvious method is connecting the TV to an RF aerial, either a roof-mounted outdoor aerial or a portable indoor aerial. If you pay a decent whack for a TV there's a possibility that it can be connected to satellite dish. This is incredibly convenient for those who live in modern flats with a communal satellite dish, as it means viewers can enjoy free-to-view satellite TV such as Freesat as well free-to-view terrestrial TV for no more than the price of the TV.

If you're in the market for a TV and would like one with a built-in satellite receiver, check out the Freesat website (**www.freesat.co.uk/get-freesat/all-tvs**) because it lists Freesat-compatible TVs from big-name brands, such as Samsung, LG and Panasonic.

If you have access to a satellite dish but don't have a TV with a built-in satellite receiver, then all is most definitely not lost. The most obvious option is to buy a subscription to Sky TV (**www.sky.com**) and choose the package that gives you the channels you want to watch. Sky subscriptions require the use of a Sky+ HD box or a Sky Q box, both of which allow the pausing and recording of live TV. The Sky boxes that are currently available from Sky right now also let you download box sets, movies and catch-up TV, and let you buy and rent movies. This is a great option for visual media junkies.

Sky's newest offering, Sky Q, takes the service one step further. While Sky+ lets you watch one program while recording a different one, Sky Q lets you record up to four while watching a fifth. The top-end Sky Q box can also output Ultra HD video, which is great news if you've invested in a Ultra HD TV and want to put it to good use. Our sister website, *Expert Reviews,* has a great assessment of the service at **tinyurl.com/zkcnmqz**.

If you don't want to subscribe to a satellite TV service, then you should consider a Freesat-compatible set-top box. There are a few different manufacturers that produce such items, such as Humax, Manhattan and Goodmans. I've always been fond of Humax's set-top boxes, although they occupy the higher end of the market and so might not be for everybody. Its Humax HDR-1100S is available direct from Humax (1TB model, £219, **www.humaxdirect.co.uk**). It's a HD device that comes with either 500GB or 1TB of storage space for recorded programmes. It has two tuners, so you can watch one programme while recording another, as long as your satellite dish supports it. The HDR-1100S also lets you watch catch-up TV via built-in apps and its Freetime service.

There are way too many TV-viewing options to list here, but one thing's for sure, you're spoilt for choice.

Andrew Unsworth has been writing about technology for several years, he's handy with a spanner and his handshaking skills are second to none

Ryan Lambie has loved videogames since he first stared up in awe at a *Galaxian* arcade cabinet in his local chip shop. 28 years on, Ryan writes about gaming for Micro Mart. He's still addicted to chips and still useless at *Galaxian*

A Tale Of Two Engines

Following a massively successful crowdfunding campaign in 2011, Chris Roberts' Star Citizen is still far from finished

This week, Ryan looks at technical troubles hampering space-sim Star Citizen and zombie survival game DayZ...

Plug & Play

On paper, *Star Citizen* sounds like the ultimate space sim: *Wing Commander* designer Chris Roberts at the helm, an ambitious vision which takes in a huge multiplayer universe and on-foot shooting as well as dogfighting in nimble spaceships. Then there's all the money it's raised: at $125m, *Star Citizen* is the most successful crowdfunded game of all time. Yet, five years on, there's little sign of the game other than a couple of playable 'modules' designed to give a flavour of the finished product: *Arena Commander*, which showcases *Star Citizen*'s space combat, and *Star Marine* – a slice of its first-person shooter element. The rest of *Star Citizen,* not least a single-player story campaign by the name of 'Squadron 42', is currently still in development.

Keen to dig deep into the production of this extraordinarily grand and expensive game, *Kotaku* UK spent around seven months interviewing *Star Citizen*'s directors, designers and programmers – several under condition of anonymity. The report provides a rare insight into the changing fortunes of a continent-spanning production.

Ironically, there's the strong implication that, had *Star Citizen* not received such generous funding, its production might not have grown to such a huge size. As the pledges kept rolling in, however, developer Cloud Imperium kept adding stretch goals, which in turn expanded the game's scope and gave the team more and more features to implement. As a result, *Star Citizen* quickly became too vast for one studio to implement, and so segments of the game were divided up and handed off to other teams or third-party contractors. The knock on of this was that tracking what all the designers were doing in these studios – split up between Texas, Colorado, California, Mexico and the UK – appears to have become a recurring problem.

A more fundamental problem is *Star Citizen*'s choice of engine. Cloud Imperium chose CryEngine; an engine tailored for first-person shooters, but not an online universe full of spaceships. According to some anonymous programmers, reworking CryEngine to run a space trading sim has taken more time and effort than building an engine from scratch.

Couple this with the decision to develop all elements of *Star Citizen* simultaneously – rather than in phases, like *Elite Dangerous* – has also apparently resulted in headaches for an already-stretched global team.

Despite the many setbacks, Chris Roberts remains confident – at least publicly – that *Star Citizen* can deliver all the features currently planned. Five years on, though, the space sim is evidently still far from complete. Right now, there's no beta version in sight, much less a firm release date. Few would fault Cloud Imperium for attempting to make a game that packs in so much, whether it's trading, combat or exploration; whether *Star Citizen* will ever emerge in a finished state is still uncertain.

Online

Star Citizen isn't the only game with a spot of engine trouble this week. If you're into zombie survival games, you may have been following the progress of *DayZ*, the standalone adaptation of Dean Hall's *Arma 3* mod of the same name. Bohemia Interactive began work on the adaptation way back in 2012 and, to date, it still hasn't left Steam Early Access.

Zombie survival game DayZ has had a troubles behind the scenes, with Bohemia Interactive struggling to get the game running on its new Enfusion engine.

If you'd begun to think that *DayZ* might have vanished, fear not: Dean Hall recently confirmed that, although he isn't directly involved in its development, the zombie game is still very much alive. One of the major sticking points, it seems, is getting *DayZ* working correctly on Bohemia's new Enfusion engine – no easy task, particularly given that, thanks to Early Access, the studio's having to effectively develop the game in public view.

While Early Access is great for building up support from enthusiastic gamers, keeping them informed of progress and responding to their feedback, the process also has a downside: if there are major technical problems during development, as there have been with *DayZ*, then there can also be hundreds or even thousands of frustrated and impatient customers to placate at the same time.

"Developing something like this, your engine and your game from day one... I mean, we hit Steam three months into principal development, effectively," *DayZ*'s creative director Brian Hicks recently told *Eurogamer*. "Principal development for us started when the team went from just Dean and just two or three guys to a full team working on it full-time. For somebody to go into Early Access development three months in from their core development process: that's unprecedented. There was no guide to this, and it has been a learning experience for us."

You only have to look at *DayZ*'s Steam page to see how the mood's gradually shifted in recent months; the number of grumpy comments and negative reviews has grown and has, as *Eurogamer* recently observed, pushed the overall consensus down from "mostly positive" to "mixed".

Nevertheless, Bohemia seems to think that *DayZ*'s most problematic days are behind it. The game was originally scheduled for a 2016 beta phase ahead of a full release in 2017; the studio still won't commit to a firm date for either of those milestones, but Hicks nevertheless insists that his team's "starting to see the light at the end of the tunnel." Let's hope there aren't too many hungry zombies waiting to devour their brains when they emerge on the other side.

Incoming

If you like your tactical games served up with a side order of cuteness, we would suggest you check out the Kickstarter for turn-based strategy game *Tiny Metal*. The concept of Japanese studio Area 34, it sees factions of chunky little war machines roll into battle, and revives the simple yet absorbing action of the *Advance Wars* handheld games.

Tiny Metal's already in impressive shape, with a playable prototype available to download from the project's Kickstarter page (which you can find at **kck.st/2d5DtCj**). With short, snappy skirmishes, *Tiny Metal*'s closer to the more arcade-y tactical games of Julian Gollop – *Rebel Star*, *Laser Squad* – than, say, Creative Assembly's vast, complex *Total War* titles. As such, it looks perfect for strategy fans who want a quick fix during a lunch break rather than hours plotting progress at their desks.

The game's almost half-way towards its humble $50,000 goal at the time of writing, and it's scheduled to roll onto Steam in June 2017. **mm**

Dinky tanks and helicopters clash in the turn-based tactical game, Tiny Metal. The downloadable prototype is well worth trying ou

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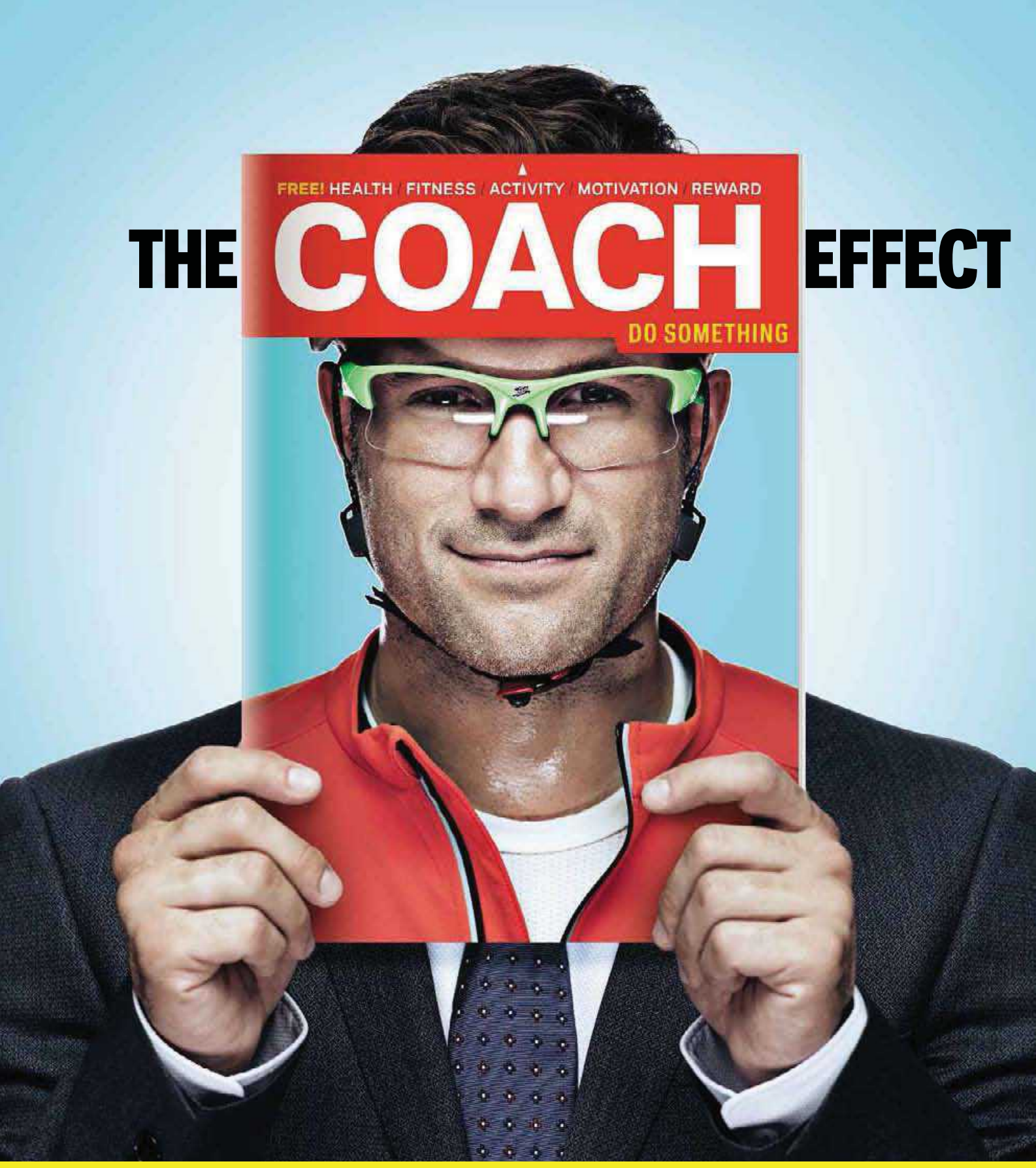

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Please try to keep your queries brief and limit them to just one question per letter, simply so we can squeeze in as many as we can each week. Please include relevant technical information too.

Aaron

Expert?

In the ask Aaron section in issue 1431, you mentioned that an ISO file is an image file and has no connection to ISO, the International Standards Organisation. Although ISO was indeed adopted by the International Organization for Standardization, it is not an acronym. The organisation adopted 'ISO' as its abbreviated name in reference to the Greek word isos (ἴσος, meaning equal).

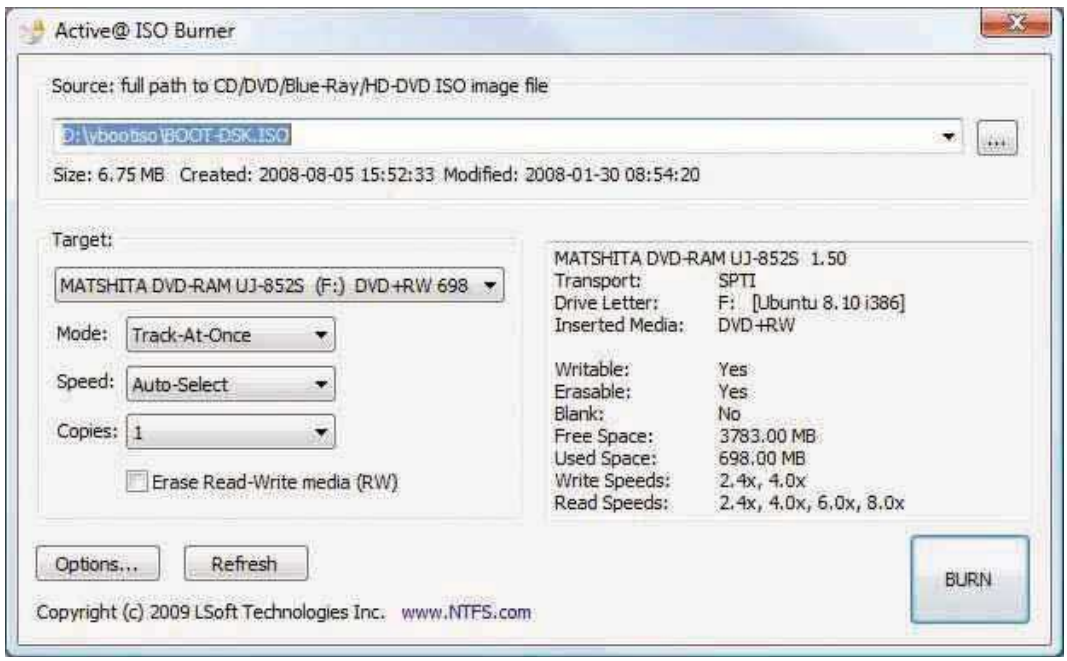
The misquoting of the organisation's name and the misunderstanding of the abbreviated name not being an acronym are both very common mistakes, and seem to be the understanding of the overwhelming majority (99%) before being taught otherwise during ISO Standards training. So please don't let your brief walk into an unfamiliar field stop you 'having a go' in the future, and keep up the great work that you all do every week to produce a publication I never miss. The knowledge I have gained from reading this magazine every week over the last 10 years has enabled me to do things with technology I could never have imagined (while not getting ripped off), and for that I am truly grateful.

Scott

Thanks for your email, Scott, although I'm unsure as to what you're getting at here. In no part of my answer to Dave did I mention anything to do with the International Standards Organization or any allusion to the origins of ISO, acronym or otherwise. I simply informed Dave that an .iso file is an image containing several files and folders, and how to handle such items, which is what the original question was about.

I'm sure our readers will appreciate the brief Greek origin of the term, though, so once again, thanks for your input.

In PC storage .iso files, regardless of the origins of the term, are simply image files containing many files or folders



Windows Update Woes

I hope you can help me, as I am being driven mad by a simple problem!

Prior to the Windows 10 rollout, I decided I didn't want it and downloaded a program called 'GWX 10' (I think), which prevented the automatic upgrade. Everything was fine, and once the date of the free upgrade had passed I deleted the program.

However, I then checked Windows Update and noticed it hadn't updated anything in over three months. I checked that automatic updates were still on, they were, and then clicked 'check for updates'. But this just got to 'checking for updates' and never progressed. I tried many fixes but nothing worked.

After a while, I decided to just bite the bullet and reinstall Windows and start afresh. Installation went fine, I formatted my SSD to make sure any old junk had gone, then activated Windows. Then, before I did anything else, like installing any software, antivirus, etc, I went straight to Windows Update and clicked 'check for updates'. And to my disbelief it only got to 'checking for updates' again! I left it running for five hours, but it never got past this stage.

Please help! I have no idea what to do next. I thought a fresh install would fix any problems, but it hasn't, and I'm at a loss how to proceed. I've used the installation media with Windows 7 several times before without any problems, so I don't think that's the problem. Googling didn't get any answers either (other than discovering a conspiracy theory that Microsoft has deliberately

sabotaged updates for people who declined Windows 10!). Any ideas?

Leonard

Conspiracy theories aside, I don't think you've got much to worry about here, Leonard. The Windows 7 update problem, even on a fresh installation, has been a cause of concern for many users, but for the most part, it's not actually all that troublesome to get over. Most users have found that you just need to give the update plenty of time, even leaving your PC overnight, during which it'll eventually download the updates.

Give this a go, and also keep an eye on the actual downloaded updates, because some have had problems with specific items in the list. These problems have been bypassed by manually downloading specific trouble-causing updates instead of leaving the job to Windows Update to handle.

If this approach doesn't work, then a Fix It patch from Microsoft may be the solution you need. This was issued to address slow updates and high CPU usage problems for Windows 7 and Server 2008 R2, and it could be what you need. You can grab the patch from ***support.microsoft.com/en-us/kb/3102810****. Be sure to download the correct version for your system, and once run, reboot your machine for the best effect.*

Alternatively, there's an automated patch you can get, which Microsoft released to address freezing problems for updates in Windows Vista, 7, and 8. You can grab this from ***goo.gl/TpHpiw****.*

The file you need is under the Windows 7 and Vista section, part of method 1. The site also includes instructions for fixing the problem manually, which some readers prefer. As with any system-editing, backups are always advised if applicable, including the registry.

Once you're set, open up an admin command prompt, and then type 'net stop bits' and press Enter. Next, type 'net stop wuauserv' and press Enter.

We then need to delete some files, and this can be done by typing the following:

*Del "****%ALLUSERSPROFILE%\Application Data\Microsoft\Network\Downloader\qmgr*.dat****"*

*Follow this with '****cd /d %windir%\system32****' and press Enter.*

Next, the BITS and Windows Update files need to be re-registered. There are a lot of these files, as listed on the Microsoft site, and the commands are as follows. Ensure you press Enter after each one:

regsvr32.exe atl.dll
regsvr32.exe urlmon.dll
regsvr32.exe mshtml.dll
regsvr32.exe shdocvw.dll
regsvr32.exe browseui.dll
regsvr32.exe jscript.dll
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regsvr32.exe wucltux.dll
regsvr32.exe muweb.dll
regsvr32.exe wuwebv.dll

A few more commands are needed which will reset various other items, so type the following, pressing Enter after each.

netsh reset winsock
proxycfg.exe -d
net start bits
net start wuauserv

*The BITS queue needs to be cleared, so type '****bitsadmin.exe /reset /allusers;*** *and press Enter.*

You'll then need to visit ***goo.gl/58MJZS****and install the latest Windows Update Agent.*

Finally, with all of this done, reboot the system and give the updater a go.

As you can see, it's a bit of a chore, so the Fix It file will be best for most, but at least you can see what the file does behind the scenes.

There are a couple of other possible solutions for this, both on the Microsoft page and used by others to remedy the problem. These include running a System Restore or performing an in-place upgrade, but as you've already performed a format and reinstallation, I doubt these will be of much help.

You mentioned you downloaded the GWX application in order to avoid downloading Windows 10. However, this tool was actually the Get Windows 10 tool, designed to allow users to download and install the new OS over the internet. Still, you clearly avoided Windows 10, which was your goal, so there's no problem.

▲ ***Windows Update suffers from a few problems, including updates for older versions***

ASK JASON

Meet Jason D'Allison, a veteran of Micro Mart's panel of experts. He's here to help with any technical questions, including anything to do with tablets or smartphones, as well as PCs

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Jason

On Yer Bike

Can the Garmin Nüvi 57LM satnav, or any other reasonably priced 5" satnav (the 57LM costs around £80), be used on a push-bike? The specs don't mention such usage, so I'm wondering if it only works when wired into a car. Garmin's bike-based satnavs are about three times the price.

Heather, TalkTalk

The Nüvi 57LM is certainly aimed at car drivers, yes, but in theory you could use it on a bike. It has its own battery, and the only connection in a car is to the lighter socket, for recharging. There's no reason why you couldn't carry the device around.

There are a couple of gotchas, though, Heather. First, as it's designed to be attached to a windscreen, you'll struggle to find a mounting bracket suitable for holding it on your handlebars. You could wear an armband, but again, getting one the right shape and size could prove tricky. Second, Garmin reckons the battery on the 57LM lasts only for two hours, which may be far too short for your needs.

The charging port is actually just a mini-USB socket, so I guess you could take a power bank with you, one designed for phones. When the Garmin's battery got low, you'd just connect the power bank and carry on. Note, however, that a power bank's cable will be micro-USB, not mini-USB. That's not a big problem, as a mini-USB cable can be had on eBay for 99p.

You'll see I mentioned phones above, and that's really where you should be looking, I feel. A cheap Android phone – maybe you already have one – makes a fine satnav. The main problem is that maps are usually downloaded as needed, during a journey, so a 3G or 4G data connection is required. With car-based satnavs, maps are preloaded. However, both Google Maps and Here WeGo – the top two navigation apps for mobiles (both free) – allow maps to be downloaded in advance, meaning your phone won't even need a SIM inserted.

Can a car-based satnav be used when walking or cycling?

What's The Solution?

A relative of mine has a pretty old E-System 1211 laptop. The CPU's a Celeron 560 (2.13GHz, single-core), and originally there was 512MB of RAM, an 80GB HDD and Windows Vista Home Basic (32-bit). Last year, I undertook some upgrades, fitting 2GB of RAM and a 320GB HDD and installing Windows 7 Professional (32-bit).

All was well, but a couple of weeks ago, Windows stopped booting. The repair option has proved no use, so I've just performed a full reinstallation. The PC's booting again, but the LAN port and wi-fi are down. The card reader doesn't work either. I realise that drivers are probably the issue here, especially as the laptop's driver disc only includes drivers for XP and Vista. I figured Windows 7 would be okay with the Vista drivers, but I don't think they've installed properly.

I know the USB ports are working (I've attached a USB card reader), so I've just tried a spare 802.11n wi-fi dongle, hoping to get online that way to get everything updated. The driver for this seems to have installed, but there's still no internet access. As a last resort, I'm thinking of formatting the HDD and reinstalling Vista, along with the laptop's original drivers, and then putting Windows

7 on as an upgrade, not as a clean install. Would this get the old E-System 1211, and my not-so-old relative, up and running again?

Geoff Spanner, Virgin Media

You're quite right that this is a driver problem. Please don't reinstall Vista, though, Geoff. Windows 7 as an upgrade is no more likely to equip the laptop with the correct drivers than Windows 7 as a clean install.

The answer is to put your relative's laptop aside for the moment and get in front of a PC with internet access. Once you've found them, save the needed drivers to a USB stick. The snag, however, is that E-System machines are poorly supported. It's a brand sold by Currys and PC World, with the official help site being ***www.knowhow.com*** *(long gone are The Tech Guys). It surprises me not one whit to discover there's no mention of the E-System 1211 – or of any E-System at all. I'm afraid you'll have to go on a hunt with Google, though I've tried that and failed.*

Ultimately, I fancy you may have to download DriverPack Solution. You'll find that at ***goo.gl/8TbniN****. It's basically an enormous Windows driver database. If Windows 7 drivers for the E-System 1211 actually exist (I guess they must, as you've had the machine romping along in the past), DriverPack Solution will have them.*

There's an online version of this tool now, but of course your relative's laptop isn't online – yet. The download version weighs over 11GB (for release 17.x, the latest), so you'll need a 16GB USB stick. It's delivered as a torrent too, so you'll also need a torrent client. I recommend µTorrent (the free version): ***goo.gl/J2HSwQ****. The download is an .iso file, which will have to be extracted. For that, try ISO Opener:* ***www.isoopener.com****.*

Once you've got the extracted files on the USB stick, George, shove the stick in the E-System 1211 and double-click the main .exe file. DriverPack Solution will then detect the laptop's hardware and offer to install the correct drivers. Be sure to untick the boxes for the extra software it'll try to slip past you.

DriverPack Solution has become increasingly swish over the years, and it's still an invaluable tool, but watch out for the extra software it'll try to install

You're Barred!

In issue 1432, Alex Peters was suffering from a poor Vodafone signal at home and wanted advice on unlocking his phone and switching to Giffgaff (O2). I duly helped, but it seems I may have overlooked something obvious...

I'm even worse off than Alex Peters. Where I live, there's no Vodafone signal whatsoever. In fact, there's no signal from *any* phone provider. However, I've bought a Vodafone Sure Signal, which acts like a personal cell tower. The signal on all the phones in our house is now a full five bars! This magic box costs £69. You just log on and off you go.

Clive Williamson, Gmail

A very good point, Clive. In the back of my mind, I was aware of such devices, so I should at least have made passing reference to them. In my defence, as I so very rarely use my phone to actually make calls, signal strength at home isn't much of an issue for me personally. As long as I've got wi-fi, I'm good. Still, not everyone's the same, are they? My bad (do people still say that?).

As you say, the Sure Signal box creates a local 3G signal (this type of device is called a femtocell), and from there it uses the internet, via an Ethernet cable to the home's router, to connect to the actual phone network. It's all transparent to the user – everything happens automagically.

The other main networks offer similar devices: EE has the Signal Box; O2 has the Boostbox; and Three has the Home Signal box. They all cost broadly the same as Vodafone's affair. I'd argue that anyone living in a reasonably built-up area should be getting decent coverage in the first place, and if that's not happening (despite the online coverage maps showing it should be), a booster box ought to be free. I believe if you kick up enough stink that's sometimes the case.

If you're struggling to get a phone signal indoors, you'll most likely benefit from a femtocell (otherwise known as a 3G booster box)

Crowdfunding Corner

This week's Crowdfunding Corner shows a pair of projects that are overtly Apple-inspired, proving once and for all that even if you're not interested in the Apple monoculture, it's still coming to get you one way or another…

AP40 Bluetooth Controller

To celebrate Apple's 40th anniversary, gaming company 8BitDo has launched this Kickstarter for a retro-styled wireless Bluetooth controller. Designed to pay homage to the original Apple Rainbow logo, it's compatible with iOS, Android, Mac OS and Windows straight out of the box. Better yet, if you couple it with the company's 'Retro Receiver' accessories, you can use it on the likes of the NES, SNES and Apple IIc.

The simple old-school design hides a number of features aimed at modern gamers. It's got a pair of shoulder buttons as well as four face buttons, analogue thumbsticks, a d-pad and select/start buttons. There's even a removable leaf so you can complete the look if you want! A bundled stand resembling an Apple II base unit can be used both as a cradle for the controller or a stand for your tablet/phone while gaming. It looks simply fantastic.

The project is being run in Hong Kong Dollars, so while the amounts look high, it's actually very affordable. You can get a controller for HKD380 (£38), or a limited edition controller and stand for HKD535 (£53), which is limited to 1,976 units (1976 being the year the Apple II came out). Devices will ship in January 2017 and, unsurprisingly for such a charming product, the HK$125,000 goal is almost met and bound to have been hit by the time you read this.

URL: kck.st/2dGk2if
Funding Ends: Wednesday, 26th October 2016

Magbolt Phone Charger

Inspired by the MacBook's magnetic charger, this adaptor is a single Lightning/mini-USB plug, which sits in your phone and allows you to charge your phone using an associated magnetic cable. Never again will you fumble around in the dark trying to fit your cable into an improbably small hole: simply get it within connecting distance and let the elementary forces of nature do their stuff.

The cable can work as a power, data, and audio connector just like your normal USB cable – the only difference is that it's magnetic, making it dirt-resistant and super-convenient to use. It even supports fast-charge where available.

Best of all? It's super-cheap. You can pick up a MagBolt connector and cable for just $19 (£15), compatible with both mini-USB and Apple's Lightning port. You can add extra cables and connectors for a small additional sum. There are higher tiers for the iPhone 7 exclusive version and a USB Type-C connector version, and you can buy multiple units at a discount. Every tier includes free shipping, and the devices will be sent out in December 2016.

URL: kck.st/2dgKfBN
Funding Ends: Saturday, 26th November 2016

Disclaimer: Images shown may be prototypes and Micro Mart does not formally endorse or guarantee any of the projects listed. Back them at your own risk!

App Of The Week

vHack XT – Hacking Simulator

We relive the glory days of WarGames

We haven't had any Android games of late, so we thought we'd cover something that we've been playing with for the last few days: *vHack XT*.

As the title suggests, this is a hacking simulator game, where you're tasked with hacking other player's virtual computers in order to obtain money. The money earned from each successful hack will allow you to upgrade your own computer, defences and hacking abilities to further increase your hacking income and protect you from other players.

It's not a hugely complex game, and you're not required to suddenly learn how to inject SQL code into a database or anything, but it's quite interesting nonetheless.

Hack Or Be Hacked

The UI is broken down into nine segments: Console, Upgrades, Mail, Log, Ranking, Cluster, Notepad, Tasks and Botnet, with your current income, Adware activity and the in-game shop along the top, and a daily challenge list, in-game events and daily special packages along the bottom.

The Console is where the main action takes place. Tapping it will bring up a list of available nodes, from which you can scan, based on your current level. Level 1 nodes are easiest, and selecting one then tapping the Scan button will bring up the current defensive levels of the other player's virtual machine.

If their defences are low enough, you'll be given a brief summary of just how successful your hack will be. A high success rate will yield more money hacked from their account and a rise in reputation. An unsuccessful hack will lose you reputation and will most likely appear in their logs, together with your IP address (all virtual, by the way) for them to hack you back.

If you're successful, you can end up hacking over 40% of the other player's current bank account, and to further your income, you can upload an adware program to create an hourly income.

Your current income is based on how much spam you can inject into the other players through uploading a trojan. The higher your Spam levels are, the more hourly income you'll receive beyond any adware you've already uploaded.

The money earned can then be used to upgrade your own system. Defence is important, but you'll also need to build your offence and hacking abilities, as well as your own hacking PC in order to deliver payloads quicker and more effectively.

If you're high enough, you'll be able to attack other players while defending yourself against lower-ranked players. And you can also create a cluster of other hackers or join an existing one, to share the wealth of multiple hacks.

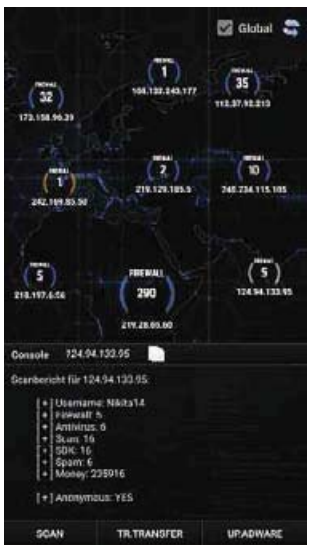
Become Number One

As you progress, you'll be able to unlock special daily packages and botnet PCs that can earn you in-game currency. You'll also get the chance to complete specialised tasks. These, in turn, will boost your rank, until you're in the top 100 hackers in the game.

There a lot more than can be done, naturally, but we've covered most of the basics here. The game has its flaws, but it's quite addictive and a decent bit of fun once you get to the higher levels.

If becoming a hacker appeals to you, then *vHack XT* will scratch that itch until you learn how to bring down missile silos in real life. (Note: please don't actually hack anyone for real – especially not us.) **mm**

The main UI is where you'll plan your hacks and upgrade your abilities



Scan a player, inject a Trojan and earn some money

Don't forget to upgrade your own defences, though, or you'll lose everything

Logging Off

Over the past few decades, technology has gone through a number of distinct phases, as it transitioned from things that barely worked to those that functioned better than expected.

With the first computers, I recall being shocked when it did something it was supposed to do, and these days I'm always waiting for it to do something unexpected. However, the real change is in the sheer complexity of what we're now building, with even the smallest parts having billions of parts that all need to be pulling in the same direction for it to function.

Looking at recent news stories I'm beginning to wonder if we're approaching a new phase, because our ability to design and build things appears to have exceeded the ability to see how they might reasonably go wrong.

If phones aren't hissing, they're bursting into flames. And if the software on your PC works now, it won't next week, once it's been upgraded.

Much of the problem, I suspect, is that building a phone, car, processor, etc. is a complicated exercise that requires the coordination of many hundreds of people, not all of whom have a grasp of the challenges faced by their colleagues.

This isn't a new thing, but the granularity of modern technology exposes us to it more and more.

At one time, you'd stand at a train station and look at the arrivals/departures board, and all it could present was letters. Maybe one might be broken or missing, but you could probably work out what 'BIRM9G AM' might be. If it worked 90%, that was enough. These days, you've got a digital display that could easily not work at all or have a message saying the PC driving it has crashed or would like to upgrade to Windows 10.

This all-or-nothing mindset of modern tech is probably its greatest weakness, because it only takes a minor thing to be wrong, and it immediately becomes expensive junk. This is something the military has been wrestling with for decades, because if a tank, plane or ship is damaged, it needs to work somewhat rather than not at all.

The phrase they use is 'graceful degradation', where a plane, for example, doesn't fly as well or as fast as it once did, but at least it remains airborne.

This is a radically different approach to engineering, because it's one that puts the customer first and what they'd like, ahead of

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minor details, like if it comes in rose gold.

At this time, that's where our modern devices fail most, because they're generally built to enhance the profitability of the maker and not to do the job that people buy them for.

The good news is that it only takes one company to realise that being customer focused doesn't need to be detrimental to the bottom line, and they'll all be forced to grasp that thorny branch.

As a big user of technology, I really hope this new era is just around the corner, because I'm heartily sick of being promised features that never arrive or, when they do, have limitations that weren't mentioned. And devices that don't work need to become a thing of the past, before we all become cynical about the latest 'amazing' product.

The product recalls and software patches need to end, and end soon.

Mark Pickavance

LAST WEEK'S CROSSWORD

Across: **7** Social Network **8** Métier **9** Induce **10** Equinox **12** Unzip **14** Field **16** Prevent **19** Stress **20** Xerxes **22** Olfactometers.

Down: **1** Pole **2** Bikini **3** Blériot **4** Remix **5** Sweden **6** Friction **11** Quintile **13** Proxima **15** Leeway **17** Verity **18** WS_FTP **21** Euro.

67 days. That's all it took for Sam '400k' Allardyce to be shown the door by the FA. Yes, just over two months is all he could manage in charge of the England football team, before doing something so monumentally stupid that his employer had no choice but to get rid of him (although he left by 'mutual consent'). What next for Big Sam? Will he go back to management? Or will he once again become the host of a Teletext quiz game (look up Bamber Boozler)? Who knows, but one thing seems sure: in spite of his dramatically curtailed tenure in the hot seat, Sam is sure to be remembered. In 50 years time, people might have forgotten the dull reign of Steve McClaren and the tactically inept Kevin Keegan era, but Allardyce will probably forever be the man that lost the England gig well within the average employment probation period. On the plus side, he'll have a lot more time on his hands to earn money from Far East companies.

THIS WEEK'S CROSSWORD

Across

7 Legal processes whereby judges review evidence and arguments, including legal reasoning submitted by opposing parties or litigants to reach a decision, which determines rights and obligations between the parties involved. (13)

8 Stretched out or arranged like a string. (6)

9 A representation of a plan or theory in the form of an outline or model. (6)

10 Very low cost desktop PC for the developing world: comes preloaded with a wealth of educational content, thus facilitating learning for students without internet access. (7)

12 Ctrl+P (5)

14 Make a PC file system accessible. (5)

16 A way of life in which people are caught up in a fiercely competitive struggle for wealth or power. (3,4)

19 By day, the millionaire socialite Bruce Wayne, by night a cloaked and masked figure fighting crime in Gotham City. (6)

20 A digital distribution platform for most devices. The service distributes games and related media online, with a primary focus on small independent game developers. (6)

22 Fitting this should prevent your high-performance PC from overheating. (6,7)

Down

1 Full-screen text editor, included with MS-DOS 5 and 6. (4)

2 A building society or insurance company owned by its members and dividing some or all of its profits between them. (6)

3 A feeling of revulsion or strong disapproval aroused by something unpleasant or offensive. (7)

4 In MS-DOS, this command suspends processing of a batch program and displays the message 'Press any key to continue'. (5)

5 Something written in a secret code. (6)

6 A device such as a rhyme or acronym used to aid recall. (8)

11 The Romance languages – often used for scientific nomenclature. (3-5)

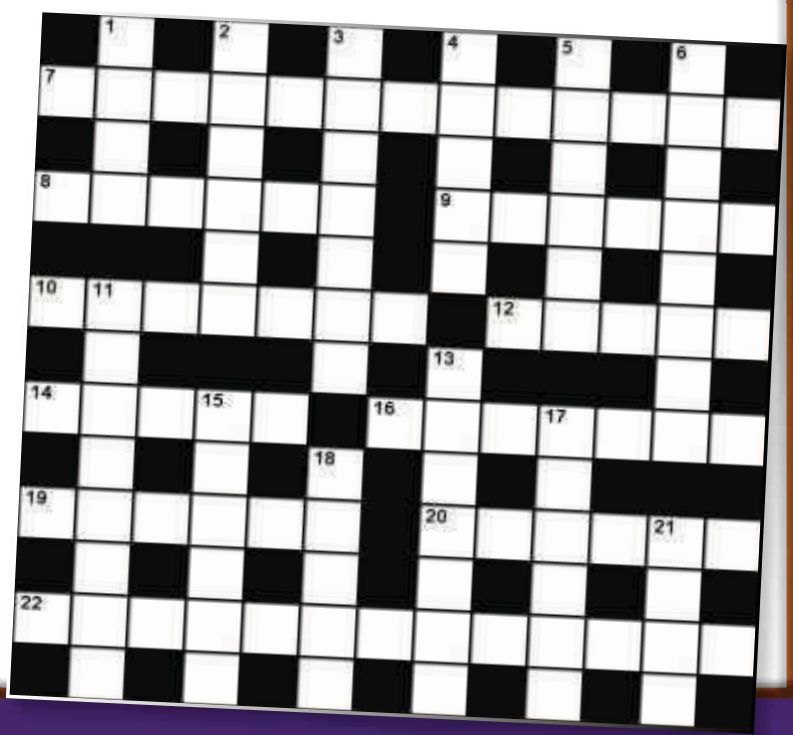
13 A computer security mechanism for separating running programs – often used to execute untested code or untrusted programs. (7)

15 A large, grey, rain-bearing cloud. (6)

17 In computing, the return value of a function. (6)

18 The negatively charged electrode of an electrical device, such as a primary cell, that supplies current. (5)

21 The largest integrated single-site precious metals refining and smelting complex in the world, established in South Africa in 1920. (4)



Top 5 Code-Name Conventions

Proving technology people have a sense of fun...

1 Android And Sweet Foods

Never one to shy away from silly-sounding names, the silly-sounding Google decided to name almost every major version of Android after some kind of sugary treat. In fact, the naming convention didn't start until version 1.5, when the term Cupcake was used. Before that, Google simply released Android 1.0 and 1.1.

Since then, we've seen Eclair, Froyo, Gingerbread and so on, right up to Nougat, which was released in August 2016. Whether you're a fan of sweet foods or not, you have to admit these names are a lot easier to refer to than the version numbers.

What comes after Nougat? Well, if Google sticks with the system, it'll be something sweet beginning with 'O'. What about something healthy for once, like 'Orange'?

2 OS X And Cats

Before giving its operating system boring names like Yosemite and El Capitan, Apple did something much more fun with OS X: it named each version after a big cat of some sort. Within the company, internal code names are used, and these have traditionally been wines, but for release, versions 10.0 to 10.8 were all given feline-inspired monikers. First, there was Cheetah, then Puma, then Jaguar and so, until it ended with Mountain Lion.

The very first beta version of OS X, however, was named after a type of bear: Kodiak. And before OS X, earlier Mac OS versions followed a musical theme, with names like Harmony, Tempo and Allegro. Fun, but still not as good as cats.

3 Ubuntu And Alliterative Animals

The Linux universe is full of interesting names and fun little in-jokes, and Ubuntu, one of the most well-known distros, embraces that. Canonical, the firm behind this popular version of the OS, favours animals as its inspiration for its version names. But rather than just using these names on their own, Canonical also likes to add some kind of alliterative adjective too.

This began with Warty Warthog, then Hoary Hedgehog. After that came Breezy Badger, followed by Dapper Drake. At this point, the names started coming in alphabetical order, with Edgy Eft, Feisty Fawn, Gutsy Gibbon and so on. This month, we'll get to see Yakkety Yak – a name that surely deserves some kind award.

4 Debian And Toy Story

Did Debian 1.1 create a buzz in the software world? Maybe, maybe not, but it was actually called Buzz, after the animated character Buzz Lightyear. After that came more of the *Toy Story* gang, such as Rex, Woody, Etch, Squeeze and so on. But why?

Well, the link is a certain Mr Bruce Perens, a multi-talented computer programmer and open-source advocate. Among his many achievements, he is credited with creating the first manifesto of open-source software. Indeed, Peren's CV is hugely impressive, but most importantly, he spent 12 years working for Pixar, the company that created *Toy Story*. And while he was still working there, he became the project leader for Debian. The rest, as they say, is history.

5 Photoshop And Movies

Unlike some companies, Adobe is fairly shy about its code names. They don't tend to feature in advertising material or anything like that, and it's much more difficult to understand the theme. How, for example, does Fast Eddy relate to Big Electric Cat or Dark Matter?

Maybe the code-name for Photoshop CS3 will give you a clue: Red Pill. That, of course, is a reference to The Matrix. Could movies be the theme? Is White Rabbit a reference to Harvey (1950), a movie in which James Stewart shares the screen with a 6ft-tall anthropomorphic rabbit? Is Stonehenge a nod to This is Spinal Tap?

We're not entirely sure, but it's fun trying to guess. **mm**

An unlikely collaboration between Apple and Google?

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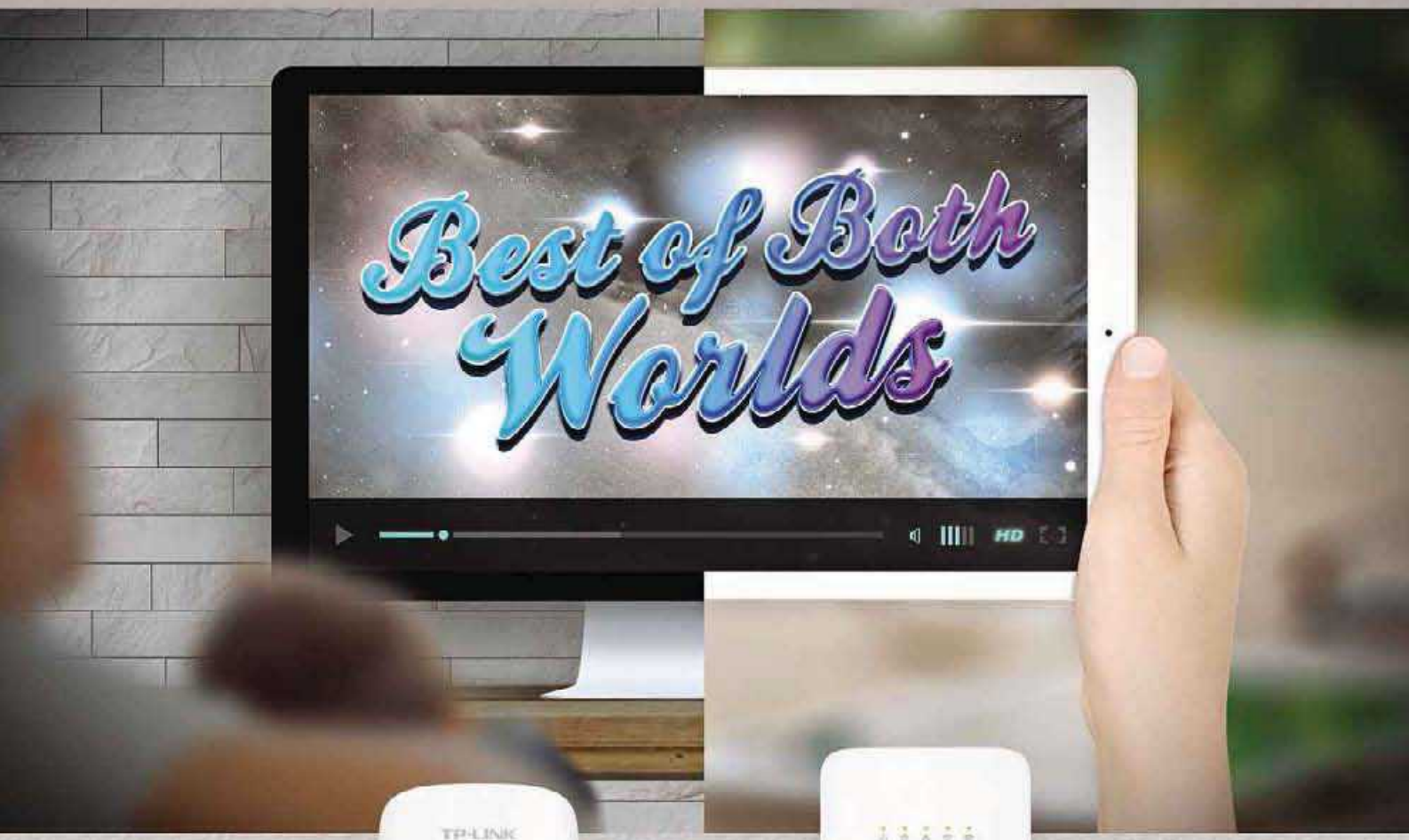

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